THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XIX.—No. 474.

AMERICAN TELEPHONE PATENTS.

THE mind of the electrical public in this country is at present engrossed with the question of legal rights in regard to incandescent lamps, and for the time being the other great electrical controversy, the battle, legal and epistolary, which has for half a dozen years or more been waged over that simple but wonderful little instrument, the telephone, has fallen somewhat into the background—to emerge again from obscurity, doubtless, when a favourable opportunity occurs. A momentary slackening of interest, however, will probably be caused by the reservation of their judgment by the Lords Justices before whom the appeal in the case of the Edison and Swan Company *versus* Woodhouse and Rawson has been argued, and in the interval our readers will possibly find their attention sufficiently disengaged to bestow a few moments of consideration upon the position of affairs, telephonically speaking, in the United States. We have before written in this connection that our cousins across the Atlantic are nothing if not sensational: and the latest development, so far as we have yet heard, of the litigation anent telephones presents a singular confirmation of our statement. An enterprising New York newspaper, which is not entirely unknown outside the city and even the nation in which it is produced—no less a power, in fact, than the *New York Herald*—has taken it into its head to make this question of telephones, which has assumed national importance in America, its own; and the means by which it has sought to achieve this object are so original as to be eminently characteristic. The *Herald* leaves the policy of vague argument to its more verbose rivals, and goes straight to official sources for statements of fact. In its issue for December 2nd, it puts before its readers a story which is straightforward and simple enough in its language, but which certainly seems to merit in its significance the term "startling" applied to it in the alliterative and romantic, but decidedly apposite headings with which it is introduced. We will try to follow the example set us to this extent—we will give our readers the facts and leave to them the task of drawing whatever inferences they may find suggested.

In the REVIEW for December 3rd we announced that, to borrow the terse phrase of the *Herald*, "something has happened in Ohio;" in other words, that the Circuit Court of the State of Ohio had declined to hear the suit which the Government endeavoured to bring before it with the view of testing the Bell patent, on the ground that it possessed no jurisdiction. The location of the American Bell Telephone Company, which is the defendant in the action, is at Boston, and in the natural course suit should have been brought in the Massachusetts Court; but it had been openly said for some time that the Government had grave reasons for striving to obtain a trial outside the State named. The attempt having failed, the action will have to be tried in Massachusetts or be abandoned; it is scarcely probable that the latter course will be pursued, and in order to make matters clear some explanation of the causes which led the Government to seek a hearing elsewhere seems to be called for. The *New York Herald* has pursued its enquiries with the object of discovering if possible the nature of those causes.

The leading facts in the history of the powerful telephone corporation may be very briefly cited. On March 7th, 1876, A. G. Bell secured a patent, and this he supplemented on January 30th, 1877, by a second; on these two he bases his claim to the absolute monopoly of telephony.

In 1878 Bell transferred his patents to the Bell Telephone Company, which was absorbed in the following year by the National Bell Telephone Company, and this in turn was merged in the American Bell Telephone Company, which was incorporated under the laws of Massachusetts in 1880. Meanwhile the Western Union Telegraph Company had acquired the patents relating to telephony granted to Edison, Gray, and others. Other claimants of priority in the invention had sprung up, but had been induced, by means easily conceivable, to practically abandon their claims. The Western Union Company was not, however, to be intimidated, and the oft-mentioned Dowd case was brought in the Massachusetts Circuit Court of the United States in October, 1881. This case was settled in April, 1881, by the two great corporations entering into an offensive and defensive alliance, and agreeing to a formal decree in favour of Bell. In 1881, on June 14th, the hearing of what is known as the Spencer case was commenced in the Massachusetts Circuit Court, and on the 27th of the same month Judge Lowell rendered judgment. Bearing upon this case the *Herald* gives the following facts, taken from the records of the court, as possibly explanatory of the promptitude with which a decision was given upon a question involving scientific problems much more difficult of comprehension in 1881, when the state of electrical knowledge was far more incomplete, than in 1886. 1. Edward Waite, one of the defendants, filed a statement to the effect that he was willing that an injunction should be served upon him, and that he did not intend to make any defence. 2. Counsel for the other defendant, Albert Spencer, wrote to the Bell counsel, J. J. Storrow: "Being unable to meet the heavy outlay to defend a motion for preliminary injunction herein and for the trial of the issues, we have concluded not to oppose the motion." 3. Spencer, so far as we can understand, subsequently disavowed all knowledge of or participation in this act on the part of his counsel. 4. No appeal was ever made from the judgment of Judge Lowell. Other circumstances in connection with this case seem strongly to confirm the suspicions of collusion which were raised. The decision, of course, was in favour of Bell. After the decisions in these cases, it seems to have been assumed by the Court, and not to have been

denied by the defendants in subsequent actions, that Bell was the first inventor of a speaking telephone. The Dolbear case was heard before Judges Lowell and Gray towards the end of 1882, and in reference to the lengthy "opinion" delivered by Judge Gray on January 24th, 1883, the *Herald* says :—"Its force as going to the bottom of this telephone controversy is wholly negatived by the fact that it is based on the decision of the collusive Spencer case, and the question as to whether Bell was the first inventor was conceded by the defendants." In all, five decrees were made in the Massachusetts Court, three without a final contest, with full consent of all parties concerned, and two after an apparent contest.

Now comes the most remarkable feature in this extraordinary history. With what has gone before our readers were already more or less familiar. But what they were ignorant of was that the two judges upon whose decisions the great telephonic monopoly in America has been founded, were surrounded at the time those decisions were given by relatives holding shares to a comparatively large extent. The principle that it is improper for a judge to knowingly adjudicate upon a case in which his own kinsmen have a large pecuniary stake is said to be universally recognised in the practice of the American judicial system. Judges have repeatedly refused to take any part in the hearing or decision of a case in which their relatives have been pecuniarily interested. Nobody, however, appears to suggest that either Judge Gray or Judge Lowell was aware of the false position in which he stood, and the latter specifically denies that he had any such knowledge; but the significant circumstances remain that the stock was largely owned by relatives of both the judges whilst the litigation was pending; that this must have been known by the Bell Telephone Company, by the counsel of that company, by the largest speculators in the stock, and, of course, by the relatives themselves; and that the decisions rendered by the judges operated to the vast pecuniary benefit of their kinsmen. The published extract from the list of shareholders in the Bell Company shows that at the time when the judgment was given in the Spencer case, Judge Lowell's father held thirteen hundred shares of Bell stock as "collateral" or security for loans; his brother held as his own, three hundred shares of the stock, and a smaller amount was held by his nephew. At the same time ten of Judge Gray's connections held in the aggregate one thousand and eighty-three shares of the Bell Company. When the Dolbear case was decided, his brothers, sisters and cousins, to the number of seventeen, held seventeen hundred and forty-eight shares, and Judge Lowell's relatives had increased their holding to three hundred and forty-five shares, in addition to thirteen hundred shares held by his brother as "collateral." On the morning of the day on which the judges announced the decision in favour of the Bell Company in the Dolbear case, Bell telephone stock was quoted at two hundred; on the evening of the same day it had risen to two hundred and twenty-eight, and soon afterwards it reached two hundred and eighty.

The statements of the *Herald* were variously received in Boston, Washington, and elsewhere, and some, of course, were found to ridicule the suggested importance of the "revelations." No amount of explanation or ridicule, however, will remove from the minds of impartial people the conviction that the relatives, at least, of the two judges concerned are greatly to blame for having placed the latter in such an embarrassing position.

PRACTICAL NOTES CONCERNING THE CONSTRUCTION, USE AND MANAGEMENT OF STORAGE BATTERIES.

By A. RECKENZAUN.

(*Continued from page* 584.)

IF we spread these materials upon two flat sheets of lead they will cover about 4·4 square feet each; the layer of spongy lead on one of the sheets being $\frac{3}{64}$ths of an inch deep, and that of the peroxide on the other $\frac{1}{16}$th of an inch thick. This pair of plates when immersed in a box containing acid, with their covered sides facing each other, would constitute a Faure accumulator. Unfortunately, however, the active materials will not adhere perfectly to metallic sheets, and this deficiency of good contact reduces the capacity. This explains the reason why Faure employed more than double the amount of paste for a given capacity than is being used by makers of perforated plates, for instance; but we do not at present concern ourselves about the various modes of *constructing* plates of secondary batteries, and deal only with general principles influencing the storage capacity.

(*b*) *Cells for Stationary Purposes.*

Capacity, 330 ampère hours.

Weight of peroxide in positive plates ...	15·00	lbs.
„ „ spongy lead in negative ...	11·25	„
Total weight of active material ...	26·25	lbs.

Capacity per pound of active material, 12·6 ampère hours.

Here we have 15 plates, 8 of which are negative, and 7 positive. There are in each plate 728 little squares offering a free surface of 131 square inches. The positive plates are approximately $\frac{3}{16}$ths of an inch thick, and the negatives $\frac{1}{8}$th; the volume of the peroxide is 91 cubic inches, and that of the spongy lead 62·5. The free surface offered by the positive plates to the acid is 6·37 square feet. These plates are much thicker, the metallic supports are correspondingly stronger, therefore altogether heavier and far more durable than those used for locomotive purposes; it appears that owing to the greater depth of active substance there is a smaller percentage of the same utilised. We may then be justified in saying that the capacity of an accumulator does not depend upon the *volume* of material alone, but also upon the mode of distributing it. No definite rules can be laid down, and we have to ascertain the best proportions for different types of plates by experiment.

Electromotive Force.—The E.M.F. due to the free hydrogen and oxygen is only 1·5 volts, but the normal E.M.F. of a lead and peroxide of lead element is 2 volts, whilst the initial force of a freshly-charged cell is as high as 2·25 volts; which, however, drops almost immediately when discharging. This higher figure is supposed to be accounted for "by the presence of ozone, which is oxygen charged with a higher energy in order to force the third atom of oxygen into the molecule." (Sprague, "Electricity.")

Gladstone and Tribe take the two volts to represent the normal E.M.F. of the arrangement of lead, peroxide

of lead, and dilute sulphuric acid, and they believe that the 2·25 volts obtained at the first moment is due to hydrogen and oxygen occluded on the respective plates, and which either diffuse out, or are speedily destroyed. It will be seen hereafter that the E.M.F. varies considerably with the *rate* of discharge. When the external circuit resistance is large relatively to that of the internal resistance of the accumulator, then the E.M.F. of the latter is very constant, though not absolutely so, because the internal resistance increases gradually during the discharge as the specific gravity of the acid falls, a circumstance which will be considered in conjunction with sulphating. Although during the discharge we obtain normally only two volts, the charging E.M.F. must always be more than 2·25 volts, since this represents the counter electromotive force of each cell when in the condition of the high activity indicated above.

There are actually two conditions regulating the charging E.M.F.; one is the counter E.M.F., which is slightly higher at the end than at the commencement, and the other the internal resistance, which, on the contrary, is least at the completion and greatest at the commencement of the charging process. These two influences partially counteract each other.

Rate of charge and discharge.—This depends: 1, upon the free surface of the plates; 2, upon the thickness of the plates; 3, upon the efficiency aimed at; and 4, upon the E.M.F.

If a high efficiency is aimed at, then the charging must be effected at a reasonable rate, so that the gases evolved in electrolysis can be fixed by the plates almost as quickly as they are produced. Practice dictates that the economical charging rate of the thin plates (*a*) is about 4·5 ampères per square foot of peroxide in contact with the acid; and in the case of the thick plates (*b*) about 4 ampères per square foot of free surface of the positive plates.

When charging, the metallic support (grid) assists in decomposing water, hence it is usual to take the entire surface of the plates when expressing the charging rate. The actual free surface of the positive plates in the locomotive type (*a*) is 5·8 square feet, and that of the stationary type (*b*) 9·3 square feet; the relative currents to be used will, therefore, be 3 ampères in the former and 2·5 ampères per square foot in the latter. The E.M.F. required under these normal conditions averages 2·4 volts per cell. By charging at a higher rate it is possible to accomplish the process in less time, but at a sacrifice of efficiency, because we have to employ a higher E.M.F. to force the larger current through; the gases are generated too fast, whereby a larger percentage escapes in bubbles rising to the surface of the acid. Thus whilst we may use 2·5 or more volts per cell for charging, we can under no circumstances count upon more than two volts in discharging.

Effect of the rate of discharge upon the useful capacity and the E.M.F. Tests made with cells (*a*) for locomotive purposes, with a constant external circuit resistance.

TABLE I.

Time.	Rate of discharge in ampères.	E.M.F. in volts.
9.45 a.m.	55·64	2.14
10.0 „	46·65	2·04
10.15 „	46·01	2 00
10.30 „	46·01	2·00
10.45 „	46·01	2·00
11.0 „	45·8	1·99
11.15 „	45·58	1·96
11.30 „	44·94	1·90
12.0 „	44·51	1·9
12.15 p.m.	44·51	1·9
12.30 „	42·8	1·87
12.45 „	40·66	1·87

Average rate, 45·76 ampères. Time occupied, 3 hours. Useful capacity, 45·76 × 3 = 137·28 ampère hours. At 1 o'clock the current dropped suddenly to 25 ampères, at 1.15 to 17 amperes, indicating that the cells were practically exhausted.

TABLE II.

Time.	Rate of discharge in ampères.	E.M.F. in volts.
9·0 a.m.	23·97	2·14
9.30 „	22·56	2·04
10.0 „	22·56	2·04
10.30 „	22·56	2·04
11.0 „	22·56	2·04
11.30 „	22·56	2·04
12.0 „	22·56	2·04
12.30 p.m.	22·56	2·04
1.0 „	22·35	2·0
1.30 „	22·09	2·0
2.0 „	22·09	2·0
2.30 „	22·09	2·0
3.0 „	22·09	1·99
3.30 „	22·09	1·96
4.0 „	20·7	1·9

Average rate, 22·34 ampères. Time occupied, 7 hours. Useful capacity, 156·38 ampère hours.

(*To be continued.*)

ELECTRO-MOTORS AND THEIR GOVERNMENT.

By W. M. MORDEY.

THE very interesting article in the ELECTRICAL REVIEW for December 18th, by Profs. Ayrton and Perry, in support of their well-known views on electric motors, calls for some remarks from me, as a paper of mine in the *Philosophical Magazine* for last January, and a discussion in which I took part in the columns of the ELECTRICAL REVIEW during the summer of this year, appear to be to some extent responsible for eliciting from Profs. Ayrton and Perry this statement of their adherence to their original views.

The questions sought to be answered affirmatively by their article are three in number:—

1. When they read their paper in 1883, before the Society of Telegraph Engineers, were they acquainted with the principle of self-governing shunt motors?

2. Is their method, published at the same time, of obtaining a constant speed, independent of the load, by means of differential winding, necessary?

3. Is their principle that in a motor the armature ought to be magnetically much more important relatively to the field magnet than it should be in a dynamo, right?

On the first point I am saved some trouble as I can refer to the discussion between myself and "A Student," who, although unknown to the professors, is stated to have clearly expressed their views.

Those who care to do so can see by referring to the correspondence in question in the REVIEW, commencing July 16th, 1886, and concluding August 13th, that I gave what seemed to me to be incontrovertible proof, that at the time of reading their paper in May, 1883, the professors were unacquainted with the principle of shunt regulation which I dealt with in my paper. As they now state that they were acquainted with this principle in 1882, I must modify my statement, and can now only express my surprise that the paper of 1883 does not contain a single word to show that they were aware of the all-important fact which it appears was taught to their students in 1882. Let it be remembered that in their paper they were dealing with motors generally—the paper was a broad one in its title and aims. There is nothing in it to show that they restricted the range of their enquiries. To quote from the correspondence already alluded to, the paper "was not called 'Ayrton and Perry electro-motors and their government,' but 'Electro-motors and their government,' and in approaching the subject of government, the authors were free to refer to previous knowledge on

the subject; in fact, it was incumbent on them to do so. And what did they say? 'They had made many experiments with motors of different sizes and different types, and they knew all that was known on the subject.'" And yet there is not one word to even distantly intimate that very good self-regulating simple shunt motors could be constructed. On the contrary, they say: "We will consider theoretically the general principles involved in the government of motors"—not of motors of a certain kind be it noted, but of motors generally—and then they proceed—"Governing:—A motor may be governed to run at the same speed whatever work it may be doing, *in one or other of two distinct ways.*" (The italics are mine.) "First, the power may be cut off in proportion as the work is cut off; or, second, a brake may be employed to replace the useful load removed." I need not say more on this point, except that it is now stranger than ever to me how the learned professors entirely passed over a principle of regulation of the utmost importance, when they were engaged in an examination of the subject which was evidently as complete as they could make it. Nay, more, the paper has since been separately published without addition or alteration, and used, I believe, by their students as a sort of text-book of all that is worth knowing on the government of electric motors. I am sure that under these circumstances, the professors will acknowledge that I had very strong grounds for the opinion which I ventured to express.

With regard to the second point, viz., whether their differential winding method is necessary. I believe that under some circumstances it would be useful; but that the cases where its employment would be necessary, on constant E.M.F. mains, will be few and far between. The compounding of dynamos is necessary; first, from the extreme sensitiveness of incandescence lamps to small changes of E.M.F.; secondly, to compensate for the variation of speed of even the best mechanically governed engines; and, thirdly, to compensate for loss of potential in conducting leads. In motors even a larger percentage variation of speed than is given by shunt motors is usually allowable, as is admitted by Profs. Ayrton and Perry. The other two causes for compounding do not apply in the case of motors. The fall of potential in the mains is provided for by the compounding of the dynamo, and extreme regularity of speed is not likely to be often demanded.

Profs. Ayrton and Perry refer to Sprague's re-invention of their differential winding. I may be allowed to mention that Sprague's claim to having last year discovered the principle of inverse variation of strength of field for purposes of regulation is ridiculous in face of Ayrton and Perry's differential system, and that two years and a half ago I and my assistant, Mr. Watson, patented a system of regulation which, although summational instead of differential, was based on the principle of inverse variation of field excitation.

Poor Mr. Sprague—not the Sprague of Birmingham, but the Sprague of New York—is to be condoled with on having taken out patents (1) for a law of nature probably known previously to all workers with motors, namely, that a shunt motor runs quicker when the field is weakened; and (2) for winding the coils of motors according to the mathematical proportion published in 1884 by Prof. S. P. Thompson, in Equation LIV. of his book!

Before referring to the main question dealt with by Profs. Ayrton and Perry—that of the relative dimensions of armature and field—a word must be said about an argument used by them which I have read and re-read with an ever-increasing *crescendo* of astonishment. They say that such motors as I referred to in the *Philosophical Magazine* could not be used because they required 130 ampères to do certain work. From this they argue that as the use of such a current in the case in question would reduce the efficiency of transmission by 27 per cent. per mile, these motors "could not be used in the electric transmission of power." The motor in question was a low-tension machine intended for use on ordinary lighting mains of short length, and the current under these circumstances was necessarily large. Surely it is not necessary to explain to the professors that the current is a mere matter of winding. It is difficult to see why the argument and calculation have been inserted in the article, or what possible bearing they have upon the question of motor construction and regulation. However, lest any misunderstanding should arise on this point, it may be mentioned that for a considerable time a 40 horse-power Victoria motor, of the exact type which Profs. Ayrton and Perry say "could not be used as a motor in electric transmission of power," has been in successful operation on a line of six miles of wire, with a loss of only 3·3 per cent. per mile of the power supplied to the motor. And that is in a case where there is no need to economise power, as the generator is driven by a superabundant water supply; the motor is, of course, wound to work at a high instead of a low difference of potential, but in principle it is in no respect different from the machines adversely criticised.

And now we come to the main object of the learned Professors' article, the question as to whether they were right in 1883 in teaching that in a motor the armature ought to be magnetically much more important relatively to the field-magnet than it should be in a dynamo.

In everything which they have written on the subject they appear to overlook the fact that there are many considerations of greater importance than lightness of weight. Their whole argument is directed to the question, not what is the best motor, but what is the lightest loco-motor. Because a loco-motor on a telpher or tramline, or on an electric launch, has to propel itself as well as to move something else, it does not follow that there are no other motors worthy of consideration. A railway locomotive is not the only kind of steam engine, nor would it be the best for pumping, for driving shafting, or for marine purposes.

One of their objections to the Victoria motor of my *Philosophical Magazine* article is that they suppose the ratio of its weight in pounds to the useful horse-power given out by it "far exceeds 60." I do not know on what they based this supposition. As a matter of fact, the figures given were not "far exceeded," the ratio being not quite 70. But it must be remembered that the motor in question was made for stationary work, and no special effort to reduce weight in proportion to output had been made in its construction. Indeed, my opinion is that the motor was too light, and not too heavy—it had too much copper on it. But this shows that it is quite possible to construct very good motors of comparatively light weight without resorting to what I maintain is the objectionable feature of a powerfully-magnetised armature in a weak field.

In designing a motor for any given purpose the following conditions require to be kept in view in nearly all cases:—(*a*) The speed should be low; (*b*) sparking should be a minimum; (*c*) when the load is varied no movement of the brushes should be necessary; (*d*) the economy should be high; and (*e*) in the special case of loco-motors the weight should not be excessive.

In all other applications than loco-motors the weight is of no more importance than it is in dynamos or steam-engines; and even in the special case of loco-motors, as, for instance, on tramcars or electric launches where accumulators have to be carried, it would probably be found that, merely as a matter of weight, the additional cells which must be carried to make up for the lower efficiency of light motors would more than cancel the gain of weight in the motor; while the charging and maintenance of the extra cells must be put down as so much dead loss. Then, again, with such motors as I advocate there is a very considerable simplification of the arrangements. In almost all cases, self-regulating or governing devices are quite unnecessary—for instance, a "Victoria" motor such as I referred to in the *Philosophical Magazine*, simply shunt-wound, would, if put in an electric launch, run at the same speed, whether the screw was in or out of the water. There would be no need to move the brushes and vary

the number of cells or to use a regulating resistance when the load was varied, while sparking would certainly not be the cause of trouble it is in a machine with a magnetically strong armature. In fact the motor would look after itself, instead of having to receive constant attention. In all these practical matters of smoothness of running, a motor with weak armature and strong fields possesses advantages which are dearly exchanged for a slight gain in weight.

In their paper on the subject Profs. Ayrton and Perry arrived theoretically at the conclusion, that of the whole weight of a motor the armature should have 90 per cent. and the field magnets 10 per cent.;* but said that their practical rule was to make the field magnets about one quarter of the weight of the armature—a sufficient proof perhaps that the theory was not to be too implicitly relied on. They seek to show that they were right in their view as to the predominance of armatures, by drawing a comparison between an Immisch motor weighing 70 lbs. giving 1 H.P. with an efficiency of 70 per cent., and an Edison-Hopkinson machine weighing 5,208 lbs. and giving 48 H.P. with an efficiency of 92·6 per cent. First, is there any sufficient reason to suppose that Mr. Immisch is as much indebted to Profs. Ayrton and Perry for his principles as is alleged? I think not, for this reason: A motor with a strong armature and a weak field is very sensitive as regards sparking and position of brushes to changes of load. We know, for instance, that brush-movement is a distinguishing feature of the regulation of Ayrton and Perry motors. But we are told that with the Immisch motor the position of the brushes is determined and fixed once for all, and requires no further adjustment whether running on open circuit or with full load,† exactly as I said in the *Philosophical Magazine* was the case when Ayrton and Perry's principles were avoided. Unless I am very much mistaken, therefore, Mr. Immisch's case, as far as this point is concerned, is in favour of my views, and not opposed to them. How the motor is made to run on "open circuit" we are not told; the expression is probably an error—"running light" being no doubt meant.

Secondly, a weight comparison is made, based on a calculation of what an Immisch motor ought to give if of the same weight as the Edison-Hopkinson machine. Now, a calculation of this kind may prove anything, and no one can be surprised that it is made to show that the imaginary Immisch motor of the same weight as the Edison-Hopkinson machine, and of the same type as the 1 H.P. motor, would give 168 H.P., or about three times that of the Edison-Hopkinson motor, with practically the same efficiency as the latter. It is more than doubtful whether the increase of out-put would be anything like this.

It has been mentioned, that in putting into practice a result arrived at theoretically the professors departed from that result in one case in the proportion 1 : 2·5. Apply a very similar method to the result reached in this instance, and we have

$$\frac{168}{2{\cdot}5} = 67{\cdot}2 \text{ H.P.}$$

And this would probably be about the correct amount; for my experience tells me that the output of motors and dynamos is, within fairly close limit, directly proportional to weight, and if this applies to any consistent series of dynamos, it must equally apply to any consistent series of motors, quite apart from the question whether I am right, or Prof. Ayrton and Perry are right, as to the proper relation which should exist between the fields and armatures of motors; whether motors should or should not be built on the same lines as dynamos, a question which will shortly be decided by the verdict of general practice.

To take the example alluded to by the professors, the weight of the 1 H.P. motor is given as 70 lbs., but it weighs, I understand, really 90 lbs. Let us call it 80 lbs. for the sake of the average. Then if power is directly proportional to weight, the 5,208 lbs. motor will give, not 168 H.P., but

$$\frac{5208}{80} = 65 \text{ H.P.}$$

—very nearly the result arrived at in another way.

But although, in my experience at least, there is in practice no noticeable gain of weight-efficiency in large dynamos and motors over small ones, there is, of course, a small gain in "commercial efficiency;" and there is also a very considerable gain in the ratio, which may be expressed;

$$\frac{\text{Watts (or H.P.) per cwt.}}{\text{Revolutions per minute}}$$

Within the limits of ordinary sizes of machines—that is, from a few thousand watts up to 60,000 or 70,000 watts (for, unfortunately dynamos of larger sizes than these are few and far between) this ratio will be found to very nearly or quite double itself; of course this applies to both dynamos and motors.

It may be said—it certainly will be said—that the increase of this ratio in the large machines shows that they are not being worked up to their full power or speed. To this the makers would probably reply, that they are the best judges of what limits should be put to the output of their machines, and that those limits are not kept low for any but thoroughly good reasons. The competition of the various manufacturers may be relied on to keep the output of dynamos and motors up to the highest safe point.

It is fortunately not necessary that I should attempt to criticise the details of the calculation of Profs. Ayrton and Perry. It is better to compare it at once with the available results obtained in practical experiment on a commercial scale, as I have ventured to do, and in doing so to remember the words of its authors: "if a principle," or calculation, "is proved to be wrong experimentally, it must be wrong wholly and utterly."

In conclusion, let me point out that the question cannot satisfactorily be discussed in the partial way in which it has been approached by Profs. Ayrton and Perry—on the supposition that the lightest motor is the best. They would render a service to electrical engineers by examining the matter (1) on the basis of motors generally without regard to weight; or (2) for loco-motors only, taking weight into account, as well as the practical matters of working to which I have alluded.

* *Journal Society Telegraph Engineers*, Vol. XII., pp. 334, 335.
† ELECTRICAL REVIEW, p. 470, *ante*.

ON THE TEMPERATURE CO-EFFICIENT OF CLARK'S STANDARD CELL.

By ARTHUR DEARLOVE.

IN continuation of my paper on the "Temperature co-efficient of Clark's standard cell," published in the ELECTRICAL REVIEW of December 10th, I have made the following table, which may be useful to those using the cell.

Temp. ° C.	B.A. Volts.	Temp. ° C.	B.A. Volts.	Temp. ° C.	B.A. Volts.
0	1·469	11	1·458	21	1·447
1	1·468	12	1·457	22	1·446
2	1·467	13	1·456	23	1·445
3	1·466	14	1·455	24	1·444
4	1·465	15	1·454	25	1·443
5	1·464	16	1·453	26	1·441
6	1·463	17	1·452	27	1·440
7	1·462	18	1·451	28	1·439
8	1·461	19	1·4496	29	1·438
9	1·460	20	1·4485	30	1·4364
10	1·459				

The table gives the E.M.F. of the cell at any temperature from 0° C. to 30° C., the formula used being that given in the above-mentioned paper, which, taking

the E.M.F. of Clark's standard cell at 15° C. as 1·454 B.A. volts, is—

$$E = 1{\cdot}454 \left\{ 1 - {\cdot}00074377\,(t - 15) - {\cdot}000004147\,(t - 15)^2 \right\}$$

From the above table it may be seen that the average rate at which the E.M.F. *rises* or *falls*, as the temperature *falls* or *rises*, is approximately $\frac{1}{1000}$th of a volt for each degree centigrade within the limits considered.

This will be near enough for most purposes, and when the utmost attainable accuracy is required it is necessary to determine the temperature coefficient of the cell to be employed. This it is easy to do by reference to a second cell kept throughout the observations at a uniform temperature, say at 0° C.

I may mention that the temperature coefficient of the cells in which an amalgamated platinum wire is used instead of free mercury has been determined and found to differ very little from that of the ordinary one; the cells experimented with gave a slightly lower value, but I should think the table given will be sufficiently accurate for either form of cell.

A THIEF AND FIRE DETECTOR TELEGRAPH.

THE great shop and bank robberies which have taken place in the past and present year prove that even the best mechanical safeguards cannot be regarded as fully adequate, and have drawn increased attention to electrical appliances for safety.

In the countries which have chiefly suffered, the safes in banks, shops, &c., are now more frequently supplemented by electric contrivances, and as a natural result of this circumstance, several patents for such devices have been obtained, or applied for. Amongst the patented arrangements ranks Dr. Taussig's safety telegraph, which is represented in the diagrams, figs. 1 and 2.

The conductors, L_1, L_2, in fig. 1, form a telegraphic circuit which traverses a city or district of a city a group of villas or a manufactory, &c., in which there are introduced any required number of dispatch-stations (fig. 1), and a receiving station (fig. 2). In the latter, which, according to circumstances may be established at a police office, a fire brigade station, or in a watch room, placed in telegraphic or telephonic connection with police and fire establishments, there is a Morse writer, M, with an automatic release and local alarm contact, as well as the actuating battery, B_2.

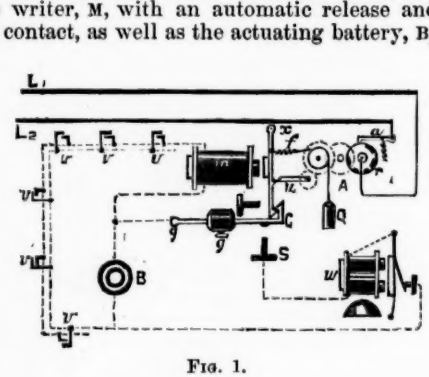


FIG. 1.

At each dispatching station (fig. 1), there is in the first place, carefully locked up, an arrangement A, which is in connection with the telegraph line, L_1, L_2, and is essentially like the well-known fire automata and similar apparatus; but it can be set in action, not merely by hand, but also electrically. A train of machinery, driven by the weight, Q, by a spring or by a column of liquid, &c., when put in action, turns the contact wheel, *r*, which in its revolutions makes or interrupts currents in the circuit, L, L_2, by which the Morse apparatus, M, at the receiving station is set in activity. Whilst the Morse at work moves an alarm in the local circuit, it writes repeatedly the signal of the automaton which is calling, as this is generally done in fire telegraphs. The peculiarity, as already intimated, exists only at the dispatch station, where the stopping arm, *u*, of the automatic machinery is held fast by a hook of steel which projects out of the keeper lever of the electro-magnet, *m*, movable on the axle, *x*. Thus the driving work of the automatic transmitter is kept motionless so long as the keeper of the electro-magnet, *m*, remains in its normal position of rest. As soon as it comes into its working position, the stoppage arm, *u*, fixed on the axle is set free, and the automaton comes into action. An ordinary self-engagement in the automatic system causes its activity to cease after a certain number of revolutions of the contact wheel, when it is ready for the next disengagement.

At the dispatching station there is also an ordinary safety telegraph installation, consisting of conductors in which are introduced the necessary number of door, window, safe, &c., contacts, *v*, or, also, thermoscopes, etc., as well as the local battery, B, and the electro-magnet, *m*. In fig. 1, these pieces of apparatus are shown as in the circuit of the working current. But they may be as well or even better introduced into the current at rest. The electro-magnet, *m*, besides releasing the clock-work, A, has the duty of setting the alarm in action as soon as one of the contacts, *v*, has been brought into the active position by the movement of its keeper. According to the arrangement shown in fig. 1, the arm, C, movable on *y*, would fall off upon the contact screw, S, by reason of the extra weight *g*, and

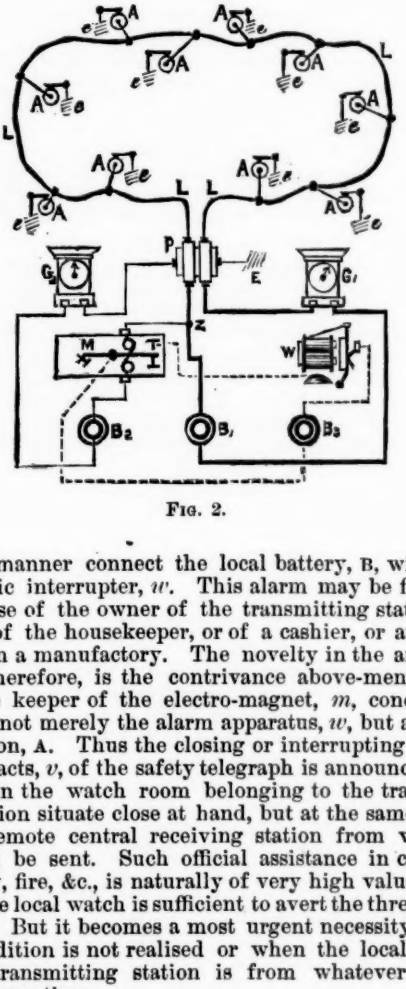


FIG. 2.

in this manner connect the local battery, B, with the automatic interrupter, *w*. This alarm may be fixed in the house of the owner of the transmitting station, or in that of the housekeeper, or of a cashier, or an overlooker in a manufactory. The novelty in the arrangement, therefore, is the contrivance above-mentioned, that the keeper of the electro-magnet, *m*, concerned, releases not merely the alarm apparatus, *w*, but also the automaton, A. Thus the closing or interrupting one of the contacts, *v*, of the safety telegraph is announced not merely in the watch room belonging to the transmitting station situate close at hand, but at the same time, to the remote central receiving station from whence help can be sent. Such official assistance in cases of burglary, fire, &c., is naturally of very high value, even when the local watch is sufficient to avert the threatened danger. But it becomes a most urgent necessity when this condition is not realised or when the local watch at the transmitting station is from whatever cause entirely wanting.

It must also be regarded as an advantage of this system that it may be very readily combined with any similar and already existing appliances for signalling. Any telegraph or telephone installation can, without

appreciable outlay or difficulty, supplement its arrangements on Dr. Taussig's system, and in many cases the step may be economically justifiable when existing fire brigades, telephone companies, &c., arrange their head offices so as to serve at the same time as safety offices, and are prepared to increase their income by the subscriptions thus accruing.

How a new installation is to be arranged will appear from fig. 2. The main wire conductor, L, L, shown in the figure by a thicker line, runs, returning into itself through the head office, where it passes the lightning conductor, P, and where a galvanoscope, G_1, and a weak galvanic battery, B_1, are introduced. It goes from one transmitting station to another, but without passing through them, and should as far as possible be carried over places where general access is as difficult as possible, such as house tops. A special branch wire leads to the automaton of every transmitting station. This wire is insulated when the automaton is in the position for rest, but in the position for speaking it comes in connection with the earth connection, *e*. A similar branch conduction exists at the head station, but there the connection with the earth is permanent, and leads from *z* through the electro-magnetic coils of the Morse writer, M, through the powerful working battery, B_2, and the galvanoscope, G_2, to the earth plate of the lightning conductors, P, and to the earth, E.

This manner of introduction, as will be seen, resembles in its essential features that which Dr. Zetsche has laid down in the fifth edition of his catechism of telegraphy (p. 265), and which has been recently patented by McCullough. It has been selected after due reflection, since the case is not impossible that a thief or a receiver might contrive to be admitted in the number of subscribers with the intention of disturbing the entire installation at some selected time by destroying his own transmission apparatus or cutting off the conductors. As far as regards an interruption of the branch conductor leading to the transmitting station, this latter source of danger is obviated by the method of connection adopted. Even the cutting or tearing of the main conducting wire does not destroy the efficiency of the installation. Even tapping the main conductor, if not too strong, can be met by a less delicate arrangement of the Morse writer. Defects of the circuit will show themselves at once at the head office. G_1 will indicate any interruption of the main circuit, and G_2 will show any additional connection. In this manner the working condition of the installation can be constantly ascertained. The service at the reception or head office should, Dr. Taussig thinks, be placed in the hands of state or local police authorities, as this is done in the American "district telegraphs" (see "Zetzsche Handbook," Vol. 4, p. 120). On this supposition care must be taken to procure and organise a suitable staff, who shall permanently occupy the head office, and shall without delay dispatch police or firemen as may be required. L. KOHLFURST.*

THE ORIGIN OF CONTINUOUS-CURRENT TRANSFORMERS.

WE (*L'Electricien*) have hitherto believed that M. Cabanellas was the first inventor of the continuous-current transformers.

It is our duty to admit, and we do do it very willingly, that the idea of this apparatus belongs to M. Gramme, as it is established beyond doubt by a pamphlet written in 1875 by our regretted colleague, Alfred Niaudet, and which we owe to the kindness of the publisher, M. Hippolyte Fontaine. We think it will be interesting to our readers if we reproduce in full the passage relating to this invention (pp. 14, 15, and 16) which will remove all doubts in this respect. It is to be noted that the author had foreseen the two methods of inverse transformations. Let us render therefore to Cæsar . . .

Transformation of Electricity from Quantity to Tension by means of the Machine.

It is known that the induction coils first created and studied by MM. Masson and Breguet (*Annales de Chimie et de Physique*, 1842), and improved with the aid of M. Ruhmkorff by the efforts of so many physicists, are appliances destined to transform electricity in quantity into electricity of high tension. Thus a bobbin of ordinary size is sufficient to transform the continuous inducing current of two Bunsen elements into an intermittent induced current giving sparks of 1 centimetre in length. We are certainly within the truth if we say that the tension of the second currrent is one hundred thousand times greater than that of the former.

M. Gramme has recently shown (*Comptes Rendus de l'Academie des Sciences*, November 23rd, 1874) that his machine may likewise serve to transform electricity and to give it a higher.tension.

For this purpose he uses a kind of non-symmetric divided ring, that is, the series of even bobbins is made with a fine wire, whilst the odd bobbins are formed of thick wire. This ring is placed between the poles of a magnet.

Suppose that we pass the current of two Bunsen elements into the thick wire; the ring will begin to turn as is explained above. But under the influence of this rotation an ordinary current (such as is given by Gramme machines) will be produced in the bobbins coiled with fine wire. There is reason to expect that the tension of the second current will be greater than that of the first, and this is what experience shows. In an apparatus thus arranged the tensions of the exciting current and of the induced current are as 1 : 8.

We have here, as is seen, a transformation of the electricity and a change of tension like that produced by induction coils; but instead of the enormous proportions of the inducing and induced currents, which may be appreciated but which cannot be measured, we find tensions having proportions which are easy to measure, and probably easy to calculate as soon as the question has been studied a little more closely.

We may say that the transforming capacity of the induction coil is quite different from that of the Gramme machine, but precisely on this account we may hope that the latter will render new services.

We will give only one instance: the current of two Bunsen elements transformed by the system just explained will give a current equal in tension to that of 16 Bunsens, and consequently a current equivalent to that of 30 Daniells, with which we can easily telegraph to a great distance.

It is important to remark that the Gramme apparatus enables us not merely to convert electricity of a lower tension into electricity of a higher tension (as just shown) but also to do the reverse, that is, to transform the tension current of 30 Daniells into the low tension current of 2 Bunsens.

It is certain that in these transformations there is no metamorphosis, but rather a loss, greater or less, and we may say, paraphrasing the mechanical truth, "What we gain in tension we lose in quantity, and inversely."

THE CLARK CELL AS A STANDARD OF ELECTROMOTIVE FORCE.

WE have received a paper by Lord Rayleigh on the above subject; the communication was read before the Royal Society on January 21st, 1886, and has since been published in the "Philosophical Transactions" of that society and also in pamphlet form.

The paper contains an account of numerous experiments made upon the Clark cell with a view to

* *Elektrotechn. Zeitschrift.*

determine whether the cell was reliable as a standard of E.M.F.

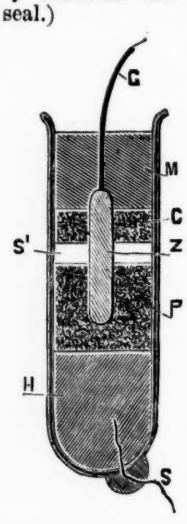
We purpose giving in this notice a short history of the experiments, the practical suggestions made by Lord Rayleigh and the reasons why failure of uniformity, which has undoubtedly been found to exist among these cells when set up by different persons, has occurred.

The principle sources of error the author says are first, the E.M.F. may be too high from two causes, the acidity of the paste or the non-saturation of the paste with zinc sulphate; second, the E.M.F. may be too low because the cell is too dry, the solution of zinc sulphate *supersaturated*, or that the mercury used may have been impure.

The paper first points out the importance of having a convenient standard of E.M.F. and shows how very easy it is to make Clark cells. Two large cells made by Lord Rayleigh, using common mercury and ordinary sheet zinc, after the first few weeks never deviated from the standard by more than one in a thousand. They are very useful when making comparisons with cells of unknown E.M.F., in which case there is a danger of passing more current through the cell than is consistent with the constancy of these standards.

The effect of the liquid or zinc sulphate solution evaporating, thereby leaving the paste dryer than it should be, is to make the E.M.F. of the cell below its proper and usual value; the precaution of firmly sealing these cells has always been considered necessary to what may be called the life of the cell.

A table is given comparing the E.M.F. of 20 cells set up, some by Lord Rayleigh and some by Mr. Threlfall; their agreement is quite remarkable, and it is stated that in many cases the cells may be depended upon not to vary relatively more than two or three parts in 10,000, notwithstanding considerable changes of temperature, in fact, as 1° C. influences the E.M.F. about eight parts in 10,000, and differences of temperature of two or three-tenths of a degree may have occurred, the values would under more favourable circumstances have been yet closer. Lord Rayleigh thinks that the chief position of weakness in cells made in the ordinary form is through employing paraffin wax to seal up the top of the cell. (Our own experience entirely confirms the treacherousness of paraffin wax as a seal.)



G, G. P. covered wire. M, marine glue. C, cork. Z, pure zinc rod. P, paste of $HgSo_4$. S, sealing wax. H, pure Hg, S', saturated solution of $ZnSo_4$.

A valuable suggestion is made as to the *best form* of cell, and the accompanying diagram shows clearly the method employed by the author of the paper, the principal advances made on all previous forms being increased simplicity, and the improved seal which is obtained by the use of marine glue in the place of paraffin wax.

A description of the way in which the cells are set up follows: sufficient pure mercury is poured in the cell to effectively cover the platinum wire, and then the paste is introduced by the aid of a small funnel, the pure zinc made in the form of rods, as supplied by Hopkin and Williams, is cleaned, dipped in dilute sulphuric acid, washed in distilled water, and, lastly, carefully dried.

Lord Rayleigh lays great stress upon the necessity of using mercury distilled *in vacuo*, and in all cells set up by him this precaution has been taken; on the other hand, he does not consider it necessary to heat the paste before charging the cells, which has usually been thought essential.

In other papers describing the method of setting up the Clark cell, great importance has been ascribed to the elimination of free acid from the mercurous sulphate, this is usually done by washing it thoroughly with distilled water; Lord Rayleigh is inclined to think this precaution unnecessary, but at the same time he states that cells set up whose paste has not been washed or treated with zinc carbonate, are some weeks before they become regular in their values. We would suggest an alternative plan, one which we have not yet known to fail; this is, to well wash the sulphate of mercury, pour the water off and allow the paste to dry by evaporation, then mix it with the zinc sulphate solution in the ordinary way; cells set up by this method quickly arrive at their correct E.M.F. and are ready for use in 24 hours. In no case need heat be applied to the *paste* or *mercury* when charging.

In preparing the "paste" the author gives the following particulars:—Rub up in a mortar 150 grms. mercurous sulphate, 5 grms. of zinc carbonate, and use sufficient zinc sulphate solution to make a thick paste, leave the whole in the mortar for two or three days, occasionally pounding it up in order to allow the carbonic anhydride which forms to escape.

Another most interesting point, and one which we believe has never been before noticed in connection with these cells, is the effect of using a *supersaturated* zinc solution in mixing the paste. Cells so set up invariably give too low an E.M.F.; though it may be constant in dealing with such cells Lord Rayleigh has found, that the addition of a few small particles of zinc sulphate generally brings the cell to its right value.

This question of the *supersaturation* of the zinc sulphate solution has been investigated on similar lines to the experiments carried out by M. Gernez on the supersaturations of solutions of sulphate and of acetate of soda, the result of which shows that when a strong solution of zinc sulphate is heated quickly it will frequently cool without any deposit, but often throws down an abnormal (lower) hydrate; on adding to this a little of the normal hydrate, the whole mass becomes crystallised and reconverted to the hepta-hydrated or normal salt.

It has also been proved that when heated up to 60° C., the Clark cell will resume its original value on cooling down, but raising it beyond this temperature *permanently* lowers the E.M.F. which is no doubt due to the decomposition of the normal hydrate. The extent of reduction in the E.M.F. depending upon this formation is about five parts in 1,000.

The next investigation made was the determination of the temperature co-efficient of the Clark cell, after numerous experiments with several cells at varying temperatures from 32° Fahr. to 67½ Fahr. Lord Rayleigh gives the expression for the E.M.F. of a cell called No. 37

$$\cdot 9985 \left\{ 1 - \cdot 00037\ (t - 52\tfrac{1}{2}) - \cdot 0000025\ (t - 52\tfrac{1}{2})^2 \right\}$$

the eqivalent which in centigrade degrees is

$$\cdot 9985 \left\{ 1 - \cdot 000666\ (t - 11{\cdot}4^\circ) - \cdot 0000081\ (t - 11{\cdot}4^\circ)^2 \right\}$$

According to this the change for one degree centigrade is the following linear function of temperature

$$\cdot 000674 + \cdot 0000162\ (t - 11{\cdot}4^\circ)$$

so that the temperature co-efficient ranges from ·000489 at 0° C. to ·000813 at 20° C. At 15° C. it would be ·00073. For cell (36) the observed E.M.F. is represented by

$$\cdot9991\left\{1 - \cdot000756\,(t - 11{\cdot}6°) - \cdot0000091\,(t - 11{\cdot}6°)^2\right\}$$

for centigrade degrees, giving for the temperature coefficient at t °C.

$$\cdot000765 + \cdot000018\,(t - 11{\cdot}6°)$$

At 15° C. the value from this formula is ·00083.

Lord Rayleigh suggests that an intermediate value should be used, viz., ·00077, and he has confidence that the adoption of this number for cells with *saturated* solutions can lead to no appreciable error in ordinary use. The final result given for the temperature coefficient, taking the E.M.F. of the Clark cell at 15° C. as 1·454 B.A. volts, is

$$1{\cdot}454\left\{1 - \cdot00077\,(t - 15)\right\}\text{ B.A. volts.}$$

We published in our journal of December 10th last a paper on "The temperature Coefficient of the Clark Cell," by Mr. Arthur Dearlove, assistant to Messrs. Clark, Forde and Taylor. The formula given in that paper was 1·454 (1 — ·00075 (t — 15) B.A. volts, which agrees very closely with the expression Lord Rayleigh gives for the temp. coefficient of these cells.

Lord Rayleigh also notices the peculiar behaviour of mercury when alloyed with other metals, and used in the form of amalgam. He was induced to make a further examination of this, when his attention was called to a valuable paper by Messrs. Hockin and Taylor, "On the electromotive force of mercury alloys," published in the Journal of the Society of Telegraph-Engineers. This paper states the following important fact :—

"Mercury alloyed with any number of metals takes the place in the scale of the E.M.F. of the most electro-positive metal it may contain, if the amount of the electro-positive metal present is not less than about $\frac{1}{1000000}$ in weight of the mercury."

As the general outcome of Lord Rayleigh's paper and its predecessors on the subject, it may be taken that the E.M.F. of a Clark standard cell at 15° C. is 1·454 B.A. volts, and that near this temperature it alters ·077 per cent. per degree.

By Mr. Latimer Clark's original determination, made some 14 years ago, he found the E.M.F. at 15° C. to be 1·457 B.A. volts, and the variation for temperature from ·06 per cent. to ·08 per cent. per degree.

Such an agreement is very satisfactory, and establishes the constancy and uniformity of the cell when set up with reasonable care and intelligence.

It is, perhaps, to be regretted that part of the apparatus used by Lord Rayleigh for the absolute measurement of the E.M.F. of this cell was identical with that employed by Latimer Clark, the particulars relating to it, which were determined by Clerk-Maxwell, entering into the calculations of both sets of experiments.

In these days, when the possession of a reliable standard of E.M.F. is particularly recognised, it is of special importance that so able a physicist as Lord Rayleigh should have re-determined the E.M.F. of this cell, and is able to speak in such high terms of its value and constancy.

ON THE SPECIFIC INDUCTIVE POWER AND CONDUCTIVITY OF DIELECTRICS.

I. THE method which we employ to measure the specific inductive power and the conductivity of dielectrics (says M. J. Curie in *Comptes Rendus*), is a method of reduction to zero, based upon the use of a plate of piezo-electric quartz as an instrument of measurement.

The properties of this instrument are the following : the quantities of electricity disengaged are rigorously proportional to the traction ; they are independent of temperature between 10° and 35°.

The substance whose electric properties are to be studied, is taken in the state of a thin plate. A true condenser with a keeper ring is produced by silvering the two surfaces and cutting out a central portion upon the silvered surface of one of them by means of a stroke made with the point of a needle.

The first surface, that on which the silvering is continuous, is intended to receive the tension of a battery of several Daniell elements ; the keeper-ring of the second surface communicates constantly with the earth, and serves at once to realise a uniform field and to remove all fear of surface conductivity. The central portion of the second surface serves for the measurements. The method consists in maintaining this central portion at the potential zero by the aid of the electricity supplied by the piezo-electric quartz. A Thomson's electrometer, acting as an electroscope, serves to show if this condition is duly fulfilled.

To measure the inductive power of the substance, we place on or withdraw suddenly from the plate of piezo-electric quartz, known weights at the same time as we charge or discharge electrically the first surface of the condenser : the weight required so that the image of the electrometer may remain at zero. The material load of the quartz measures exactly the charge condensed in the central portion of the plate.

To measure the conductivity we compensate exactly the electricity derived from a current traversing the plate by the electricity disengaged from the piezo-electric quartz when it is submitted to a gradually-increasing load, which is obtained by allowing mercury to flow in a continuous manner into a crystallising capsule set upon the plate of the apparatus. The speed of flow of the mercury compensates and measures the speed of efflux of electricity into the plate.

It is not necessary to know the absolute potential of the battery and the constant of the quartz : the ratio of these two magnitudes intervenes alone in the value of the inductive power and of the conductivity. We determine this ratio by means of a preliminary measurement made with an absolute air-stratum condenser ; we examine for this purpose what traction must be exerted upon the quartz for the electricity accumulated in the condenser when it is charged to the potential of the battery.

To measure the conductivity we may also instead of the efflux of mercury use a weight which is supported in the hand and which is let press by degrees upon the traction plate of the quartz. During this operation we keep the image of the electrometer constantly in view, and with a little practice we succeed in keeping it constantly fixed, noting the time which is necessary for the electricity traversing the plate to compensate the weight.

This mode of operating is practicable only when the intensity of the current varies rapidly in the plate. We have been able by employing it to construct the complete curve of the intensities as a function of the time for a very great number of substances.

The specific conductivities which we have measured by this process are comprised between 0·000001 and 100 C.G.S. electrostatic units, *i.e.*, these bodies have a resistance of from 10^{18} to 10^{10} ohms per cubic centimetre.

By employing the bodies in the form of elongated prisms of a small section, we may extend these measurements to much greater conductivities.

II. When we establish a difference of potential between the two surfaces of a dielectric plate, there is produced first, in an inappreciable time, an abrupt change ; the plate then becomes the seat of an electric current, this current diminishes in intensity with time, and finally takes a constant value or becomes completely extinct.

A first and particularly striking fact is the great constancy of the original abrupt change, to which corresponds the specific instantaneous inductive power and the extreme variability of the conductivity. All the specimens of one and the same body (cut in the same direction in the case of crystals) give the same value for the instantaneous specific inductive power. On the contrary, it is impossible to find two specimens identical in conductivity ; it is even not rare to find two plates of one and the same substance, equally pure, giving results which vary respectively as 1 : 5.

A variation of temperature scarcely alters the value of the inductive power. On the contrary, it modifies the conductivity in enormous proportions and this, when the body has returned to its primitive temperature, is no longer identical with what it was previously. In spite of these causes of uncertainty the mean conductivity must for a dielectric be considered as a very precise datum because at one and the same temperature two different bodies may present between themselves differences of conductivity very great and often enormous. Thus rock salt may be considered as 10,000 times less conductive than glass.

A perfect dielectric would be one which should give no current after the instantaneous charge. All bodies seem to tend towards the state of a dielectric as the temperature falls. Boltzmann has shown that crystalline sulphur is a very perfect dielectric. It results from our researches that rock salt and fluor-spar are in the same case at the ordinary temperature. Then came quartz (plate parallel to the optical axis), topaz (plate of cleavage), mica and ebonite, which are still very good dielectrics. We shall announce the other bodies which we have studied in the order of their increasing conductivity as examined at one and the same temperature.

Iceland spar (plate perpendicular to the optical axis), spar (plate parallel to the optical axis), quartz (plate perpendicular to the optical axis), heavy spar (cleavage *m*), crystal, red tourmaline (perpendicular), green tourmaline, alum, glass.

It is interesting to compare this list with that given by Melloni for the absorbent powers : rock-salt, sulphur, fluor-spar, Iceland spar, quartz, glass, white topaz, heavy spar, dark green tourmaline, alum.

In a general manner the relation pointed out by Maxwell between conductivity and absorbent power seems to be verified. It is especially decisive that the three most perfect dielectrics, rock-salt, sulphur, and fluor-spar are precisely the three most diathermanous bodies. We may further mention ebonite, a body very feebly conductive, and which according to Graham Bell and Maxwell allows invisible heat to pass. But we will abstain from taking an absolutely affirmative position as regards the relation signalised by Maxwell, and we will remark that in the present state of our knowledge it is impossible to arrive at precise verifications, because, on the one hand the intensity of the current which traverses a plate is a function of the time, and on the other hand the absorbent power depends on the wave length of the radiation. The figures given by Melloni correspond to an entire ill-defined group of radiations.

ON THE VARIATION OF THE MAGNETIC FIELD PRODUCED BY AN ELECTRO-MAGNET.

In his paper of October 26th last M. Marcel Deprez confirms a part of the conclusions which I (M. Leduc) communicated to the Physical Society on February 19th, 1886. Still, the results which we have obtained present notable numerical difficulties which may depend on the different conditions in which the experiments have been made.

I have the honour of submitting to the Academy the method which I have employed (see *Comptes Rendus* session of July 28th, 1884).

I have very particularly studied a Faraday's electro-magnet, the cores of which have the external diameter of 0·16 metre, an inner diameter of 0·04 metre, and a width of 0·28 metre. The cores are covered per centimetre of length with 27 turns of a copper wire of 0·003 metre (measured bare). To this apparatus I have adapted polar pieces of varying masses and forms. The numbers below were obtained with pieces of 0·07 metre diameter and 0·023 metre thickness.

I have ascertained that the cylindric cavity of the cores (which allows of experiments being made on the polarisation of light) has no influence upon the field produced between the polar pieces ; the value of this field is not altered in any respect by filling up this cavity with iron.

In the table below, the perpendicular column on the left indicates the distance of the polar pieces, and the upper horizontal line gives the current which passes into the magnetising coils. The numbers in the body of the table measure in C. G. S. units the magnetic intensity observed in the middle of the field.

D.	C.				
	2 ampères.	4 ampères.	8 ampères.	16 ampères.	32 ampères.
0·0025	9,060	13,400	16,930	19,400	21,100
0·005	5,400	9,200	12,960	16,130	18,800
0·01	2,780	5,460	8,440	12,200	15,830
0·02	1,430	2,820	4,800	7,320	10,930
0·04	750	1,500	2,750	4,200	6,500
0·08	360	720	1,370	2,140	3,400

As long as the distance of the armatures does not exceed 0·02, we may consider as absolutely uniform the portion of the field comprised in the interior of two truncated portions of a cone having for their greater bases the polar pieces, and for their common minor bases a circle of 0·03 or even 0·04 metre in diameter, placed in the middle of the field, perpendicular to the axis of the apparatus. It is no longer the same when we increase the distance of the armatures, so that to make useful comparisons it is necessary to increase the numbers of the fifth rank by 1 to 2 per cent., and those of the last by 8 to 12 per cent.

However this may be, it is very true that if we consider a very intense field, *this field decreases much less rapidly than the distance between the polar pieces increases.*

We see, in fact, that a field of 21,100 ampères is not reduced by one-half if we multiply the distance of the armatures by 8 ; but we see, also, that if the field does not exceed 6,000 C. G. S., for instance, we do not commit a serious error in admitting that it increases inversely as the distance of the magnetic surfaces. Thus a field of 5,400 is reduced to 1,430 if we quadruple this distance, whilst it ought to fall to 1,350 according to the crude law given above.

It is plain that the results obtained may vary enormously, according to the nature of the magnetic field. It is, however, not without interest to remark in the foregoing table that to produce a field of unvarying value whilst modifying the distance of the polar pieces the intensity of the current must be made to augment more rapidly than this distance. Hence it results that if we fix beforehand the intensity of the field to be produced it is, in a general manner, advantageous to approximate the armatures. It is clear that, as far as dynamo-electric machines are concerned, there is occasion to take account of the space lost for the insulation of the armature.

If we only pass into one of the coils of the electro-magnet a certain current, the field produced has the same value as if we passed at once into both coils a current of one-half the strength. The observations made above apply to this case.

I have observed, also, that it is advantageous to reduce the thickness of the polar pieces, and that the thicker they are the less is the variation of the field for one and the same change in the intensity of the current or in the distance of the magnetic surfaces.—*Comptes Rendus*, November 15th, 1886.

Telegraph Statistics.—From the tables which we publish in our present issue, it will be seen that the United Kingdom stands well as regards telegraph accommodation, both as regards offices and the number of instruments for carrying on the work ; the total staff employed exceeds that of all the other countries put together.

TELEGRAPH STATISTICS FOR 1885.—From the *Journal Télégraphique*, November 25th, 1886.

	Length of lines.	Length of conductors (Length of wires).	Number of offices.	Number of instruments.	Number of staff.	Total number of telegrams.	Receipts.	Expenditure.		Population.	Area.
								Staff.	Maintenance.		
	Statute miles.	Statute miles.					£ sterling.	£ sterling.	£ sterling.		Square miles.
Belgium	3,775	17,614	909	1,578	2,617	4,301,343	110,894	86,680	56,826	5,720,807	11,373
Bosnia-Herzegovina	1,998	3,168	92	129	242	273,138	12,078	11,235	4,299	1,336,091	21,112
Brazil	6,396	11,182	169	374	2,467	367,799	134,520	92,508	90,454	12,350,000	3,281,853
Cochin-China	1,359	1,799	52	75	216	137,216	3,727	18,535	3,570	2,583,824	52,706
Denmark	2,415	6,763	357	?	707	1,307,664	38,566	36,542	10,225	1,980,675	15,202
Dutch East Indies	3,588	4,856	180	322	1,586	410,246	41,537	?	?	27,099,217	642,754
Egypt	2,744	5,264	132	410	595	642,203	?	?	?	?	?
France (Continent and Corsica)	51,934	161,921	8,335	14,677	55,218	32,540,780	1,166,776	?	?	37,672,048	204,081
„ (Algeria and Tunis)	5,932	11,320	273	688	1,368	1,774,097	63,473	?	?	5,310,412	229,846
Great Britain and Ireland	29,101	169,243	6,264	18,386	96,287	40,339,019	1,758,168	1,206,967	371,849	36,331,000	121,223
Greece	4,103	4,770	151	236	775	735,233	42,632	32,692	7,060	1,953,792	24,558
Holland	2,921	10,428	595	712	1,810	3,476,050	85,782	110,833	28,553	4,336,012	12,744
Hungary	10,811	39,947	1,424	1,935	1,715	3,636,828	147,101	94,307	53,590	15,642,102	124,459
Italy	17,622	50,637	3,075	3,196	6,336	8,008,780	487,758	286,548	130,281	29,010,652	114,410
Luxembourg	239	443	71	55	28	83,947	1,142	1,905	944	213,283	998
Norway	4,565	8,477	315	266	607	865,684	51,047	44,652	14,982	1,925,000	122,855
New South Wales	10,352	19,867	404	?	687	2,642,650	148,463	119,261	53,719	980,573	192,106
Russia	67,373	126,224	3,208	3,330	?	10,886,548	1,469,403	?	?	101,342,242	8,577,624
Servia	1,724	2,464	101	177	359	417,572	19,473	16,947	2,400	1,940,000	18,795
Siam	1,056	1,087	14	17	71	7,607	896	7,833	2,655	11,800,000	308,880
South Australia	5,316	9,325	193	284	?	?	67,300	51,258	7,528	319,769	348,915
Spain	11,323	27,276	914	990	3,540	3,322,687	239,974	194,025	72,134	16,935,506	195,844

AVERAGES, WORKED OUT FROM THE ABOVE TABLE.

	Miles of line per office.	MILES OF CONDUCTORS		TELEGRAMS.			Tariff per telegram. Shillings and decimals of shillings.	RECEIPTS.		EXPENDITURE (Staff and maintenance).		BALANCE BETWEEN RECEIPTS AND WORKING EXPENSES.		Population per square mile.
		Per mile of line.	Per square mile of country.	Number of per inhabitant.	Number of per mile of conductor.	Number of per office.		Per office. Pounds and decimals of pounds.	Per mile of conductor. Pounds and decimals of pounds.	Per office. Pounds and decimals of pounds.	Per mile of conductor. Pounds and decimals of pounds.	Profit.	Loss.	
												£	£	
Belgium	4·15	4·666	1·549	0·7518	244·2	4,732	0·515	121·99	6·310	157·88	8·148	...	32,612	503·02
Bosnia-Herzegovina	21·71	1·586	0·150	0·1295	86·2	2,960	0·884	131·28	3·813	188·85	4·903	...	3,456	63·28
Brazil	37·84	1·748	0·003	0·0297	32·8	2,176	7·206	795·97	12·030	1082·67	16·362	...	48,442	3·76
Cochin-China	26·13	1·324	0·034	0·0531	76·2	2,638	0·543	71·55	2·072	425·10	12·282	...	18,378	49·02
Denmark	6·76	2·800	0·445	0·6602	193·3	3,663	0·589	108·02	5·703	131·30	6·931	...	8,201	130·29
Dutch East Indies	19·93	1·353	0·008	0·0151	84·4	2,278	2·024	230·76	8·554	... *	... *	... *	... *	42·26
Egypt	20·78	1·918	...	...	121·9	...	...	...	...	...	...	...	...	...
France (Continent and Corsica)	6·23	3·118	0·793	0·8637	200·9	3,904	0·717	139·98	7·206	... *	... *	... *	... *	184·59
„ (Algeria and Tunis)	21·72	1·908	0·049	0·3340	156·7	6,498	0·715	232·50	5·607	... *	... *	... *	... *	23·10
Great Britain and Ireland	4·64	5·816	1·396	1·1102	238·3	6,439	0·871	280·67	10·389	252·04	9·328	179,352	...	299·704
Greece	27·17	1·162	0·194	0·3763	154·1	4,869	1·146	282·33	8·938	263·26	8·334	1,880	...	79·56
Holland	4·88	3·570	0·818	0·8016	333·3	5,842	0·493	143·83	8·226	234·27	13·367	...	53,604	340·24
Hungary	7·59	3·694	0·321	0·2325	91·04	2,554	0·808	103·30	3·682	103·81	3·702	796	...	125·68
Italy	5·40	2·874	0·443	0·2760	158·1	2,604	1·218	158·62	9·633	135·56	8·231	70,929	...	283·73
Luxembourg	3·36	1·854	0·444	0·3935	189·4	1,182	0·272	16·08	2·578	40·12	6·431	...	1,707	214·20
Norway	14·49	1·856	0·069	0·4497	102·1	2,748	1·179	162·05	6·036	189·31	7·035	...	8,587	15·67
New South Wales	25·62	1·919	0·103	2·6951	133·01	6,541	1·123	367·48	7·473	428·17	8·707	...	24,517	5·10
Russia	21·00	1·873	0·015	0·1007	86·2	3,393	2·699	458·04	11·642	... *	... *	... *	... *	11·81
Servia	17·07	1·429	0·131	0·2100	169·4	4,134	0·933	192·80	7·903	191·56	7·852	126	...	103·22
Siam	75·43	1·029	0·004	0·0064	6·99	543	2·355	64·00	0·824	749·14	9·649	...	9,592	38·20
South Australia	27·54	1·754	0·027	...	...	...	...	348·70	7·217	304·60	6·304	8,514	...	0·92
Spain	12·27	2·408	0·139	0·1950	121·8	3,634	1·444	262·55	8·798	291·20	9·758	...	26.185	86·47

* The Telegraph and Postal Departments being united it is impossible to separate the relative receipts and expenses.

LARGE OTTO ENGINES AT PRAGUE, AUSTRIA.

THOUGH the days of gas power on large ocean steamers, which Sir William Siemens predicted some years ago in his inaugural address before the Royal Society, London, have not yet come, progress in the development of gas engines of large power, says the *American Engineer*, has of late been remarkable, especially in those countries where gas is cheap, as in England and Germany. We hear of water works being operated by Otto gas engines in cities of the importance and size of Coblentz and Koenigsberg, and in towns of smaller size, such as Duren and Quedlinburg in Germany, and Wallingford and Stratford-on-Avon, in England. While some of these works have a total capacity of 200 horse-power, the size of the engines does not exceed as yet 75 indicated horse-power, several engines being generally used with each plant. The Otto engine which has steadily gained in favour in this country, at first modestly claimed economy only for small engines, but with decreasing prices for gas, engines of 25 horse-power are now no rarity, but no engines as large as those mentioned above have yet been built this side of the Atlantic. Beyond 25 horse-power, the starting of gas engines by hand is difficult, and substitutes for muscular power are then resorted to, sometimes in the shape of reservoirs wherein a part of the pressure the engine produces at each stroke is stored up. By lifting a valve, this pressure is allowed to escape into the cylinder, and so start the motion. Another very simple plan is to use a smaller engine to start the flywheels by pulleys and gearing. This means is adopted in the electric light station at Prague, Austria, a 1 horse-power engine being used for the purpose. The station includes three engines of 50 actual horse-power each, of the twin type, and four dynamos to supply about 250 arc lights. The peculiar features of this plant are the absence of a boiler house and chimney, as well as coal sheds. The system has the advantage of safety from boiler explosion, and of limiting the consumption of fuel strictly to the time that power is used. Gas companies are now in some cases furnishing electric light, and may find in large gas engines the best power for their electric stations and thus bring the new light in harmony with their interests in gas manufacture. We are indebted to Messrs. Schleicher, Schumm & Co., of Philadelphia, for material for this description.

THE SUBMARINE BOAT "NAUTILUS."

ON the invitation of Mr. E. Wolseley and Mr. C. E. Lyon, a large and distinguished party of ladies and gentlemen, including Lord Charles Beresford, assembled at the Fenchurch Street railway station last Monday morning, the 20th inst., and proceeded by special train to Tilbury, with the intention of witnessing a further trial of the new patent submarine boat *Nautilus*, some particulars of which craft we gave in our issue of the 3rd inst. On the present occasion the vessel was moored in the Tilbury deep-water dock, belonging to the East and West India Dock Company, where the water, being between 30 and 40 feet deep, would afford a fair and reasonable test of the boat's capabilities in the essential feature of regulating its submergence, and of the ease with which the variations of the depth to which it is necessary to be sunk could be accomplished.

When mention of this trial was made some few week's back, it was understood that not only would the immersive and emersive qualities be exhibited, but that a full speed run would be made, and that there was also a probability of a small torpedo being discharged; somewhat to the general disappointment neither of the latter experiments was carried out, Mr. Campbell not considering it safe to go at full speed, partly in consequence of the comparatively confined space of the dock, large as that space really is, but chiefly on account of the want of training and experience of the crew, composed for the most part of visitors anxious to see the working of the machinery for propulsion and the apparatus for varying the submergence. The majority of the visitors taken on each trip were required to work their passage by presiding at some wheel or switch, the available space on board being so crowded with apparatus as to allow of scant room for idle hands. Another drawback attached to the place consisted in the muddy state of the water in the dock, precluding any observations from the conning tower when under water. The *Nautilus* was connected with a small rowing boat by telephone, and she could thus be steered from above water, or rather it would be more correct to say that directions could be sent to her by which she could steer. Her steering abilities seemed to be limited, which the little way on her, owing to the slow speed would no doubt explain, and it is to be expected that when run at a full or fair pace she will answer more satisfactorily to her helm. We shall hope, therefore, to have the privilege at some future date of seeing the vessel tried in a manner to bring out her full powers and free from any restrictions tending to prevent her qualities from being exhibited to the best advantage.

The vertical manœuvring appeared to be of a most perfect character and under the most absolute control, but even in this regulation it seems requisite to have a considerable amount of skill and practical knowledge, in rising especially, in which case should the displacement be increased too rapidly, the boat rises much too fast, and emerges to a much greater extent than it will permanently settle to, thereby exposing her to the enemy's view if used in warfare.

Although it has been hinted that this principle of displacement has been used before, we cannot recollect any instance in point, with the exception of the application of inflated skins for raising sunken boats. That method does not deprive Mr. Andrew Campbell of the credit of applying, for the first time, the principle to the effectual management of the flotation power in a submarine boat, and being thus able to drive her on an even keel. This essential improvement will probably render the *Nautilus* type of torpedo vessel the most successful among the numerous competitors, and should help to largely enhance its future value in a commercial sense.

Many attempts have been made for the last 200 years to construct a perfectly safe and effective submarine boat, but they have all been devised to work on the same lines, viz., sinking or rising by the use of water ballast or inclined fins or rudders. Failures have been many, but the use of torpedoes has given an impetus to inventors to produce such a boat. It was left, however, for Mr. Campbell to supply this desideratum in a boat which can be readily submerged or floated in a safe and simple manner, leaving nothing to chance and not depending on the power used in propulsion and ready at any moment. On each side of the vessel a series of metal cylinders are placed into which are fitted properly constructed rams or drums, which can be protruded or withdrawn by a simple process governed and worked by the crew. The speed of rising and sinking is easily and perfectly regulated, and an even keel is assured as well as safety. The inventor thus considers he has produced a boat which is under strict control, can be kept at any given depth, can be raised or sunk rapidly or slowly, and can be propelled at 10 knots an hour, and either floating or submerged may be kept for hours or days without losing scarcely any of its propelling power.

For safety the *Nautilus* is divided into four compartments, the projectors and machinery being contained in one of these and all to hand. Besides the projectors she is fitted with water ballast as well as horizontal rudders, and in case of an absolute breakdown, such as might happen by some accident, a turn of a bolt will enable the crew to release a heavy weight and send her at once to the surface.

After nearly two hours consumed in the various manœuvres of the boat, the visitors, who had been standing on the edge of the dock in an icy wind, were nothing loath to adjourn to the hotel for luncheon; at which Mr. Edward Wolseley presided. Among other toasts given that of "The Press" was included; then came the toast of the day, that of Mr. Andrew Campbell the inventor, who, in a short speech, explained the reasons for not risking a full trial in the deep water basin, and stated that he feared an accident by collision owing to the difficulty of pulling up when the vessel has much way on her, and with an untrained crew. The speaker shortened his address to enable the visitors to witness another run before darkness could put an end to all experiments. The proceedings terminated in the toast of Messrs. E. Wolseley and C. E. Lyon, through whose instrumentality the invention has been brought to its present forward state.

An adjournment was made to the waterside, but no further trial was possible, the electricians having gone to dinner and not returned.

ELECTRIC STREET CARS.

THE struggle for supremacy in this field of occupation may fairly be said to have narrowed itself down to three competitors—the horse, the cable, and the electric motor. The lowest cost of operation per steam motor per day, in usual service, that I have seen quoted authoritatively is $8.50 and $7. But even if steam were cheap, there are grave objections on the score of noise, smell, and dirt. The mere fact that steam locomotives have been in successful use 50 years but are still denied employment on the streets, tells its own story as to public opinion. To some of us the banishment of steam even from the tracks of elevated roads seems a matter of but a few years.

Coming to horses, we find that in spite of their universal use and their faithful performance of duty, they inspire a discontent anything but complimentary, yet hardly to be wondered at. The statistics of horse cars are important and interesting, and deserve our attention as covering the sphere within which the electric motor will operate. There are, according to the latest returns available for this year, about 625 street railways of all kinds in the United States and Canada. Taking of these 408 horse roads giving full and trustworthy figures, I find that they run 17,331 cars and employ 85,888 horses. If at the same ratio we took all the horse roads, upward of 500, we should arrive at a result of not far short of 25,000 cars and 120,000 horses, a total that probably comes very near the actuality. Taking the other figures, which I have tested by three sources of information, it appears that the horse-car lines are maintaining a proportion of at least five horses to each car. But that is inclusive, and making a reasonable allowance for the use of different cars for winter and summer, and for idle cars, as well as for "doubling-up" in heavy snows, a result is shown of at least eight to ten horses per car. This is the proportion usually cited, and it is brought out on a special examination of the statistics for this city. Thus the Broadway and Seventh Avenue road has 121 cars, and 1,350 horses, or not far short of 12 horses per car. The Central Park, North and East River Road, with a total of 161 cars, has 1,223 horses, a broad average of 8 horses per car. The Eighth Avenue Road, with 112 cars, has 1,155 horses, or 10 per car. The Forty-second Street and Grand Street line has 50 cars and 485 horses, or 9 per car. The Sixth Avenue line has 127 cars and 1,296 horses, or 10 per car. The New York and Harlem with 164 cars has 1,321 horses, or 9 per car. The Third Avenue Road, returning a total of 360 cars, has to keep up a force of nearly 2,200 horses. The large number of horses required is also to be learned from the fact, stated by Mr. Augustine W. Wright, that those on the North Chicago line, which is a favourable sample, work daily only two hours and seventeen minutes. Or to put it in another way, the 6,158 street car horses of Boston travel each about 10 miles a day only, or two hours' service.

The costliness of horses may be arrived at in yet other ways by the use of comparative figures. Mr. T. C. Robbins, of Baltimore, a street car expert, gives the average cost of horse car per day at $6.50. I have had the same figures given me for Brooklyn and Philadelphia. Mr. C. B. Holmes, of the Chicago Cable Railway, who has had great experience with horse service, says that the expense per car-mile by the cable system is 10 to 11 cents, as compared with 20 to 25 cents per mile when employing horses. On a daily run per car of 50 miles, that would be at least $12 per day for horse traction, and half as much for cable. Moreover, there are the great extent of valuable land required for huge stables and the heavy depreciation of stock. Few occupations are more exhausting to horses than street car traction, and the average railroad life of a horse is but from three to five years. In other words, out of 100,000 horses, at least 20,000 every year die or become useless for their work and drag out the remainder of their existence in other occupations.

The cable has already made its way into use on a large number of street railways doing a heavy business, and is it must frankly be admitted a vast improvement on old methods. It has enabled those roads to handle a traffic that was utterly beyond their capacity before. It has accelerated speed, has lessened accidents, has given the streets a cleaner look, has, it would seem, cut down expense, and has certainly raised the value of property wherever put in. But I doubt seriously whether in view of the enormous first cost of the cable system and the excessive waste of power, it will make very rapid strides, especially when subjected to the rivalry of electric motors. At the recent street car convention, the new cable roads at Kansas City were presented for favourable notice, and as they were evidently considered good specimens, let us accept the figures. The Metropolitan Road will cost $50,000 per mile of single track, and I observe that it is claimed with regard to the Philadelphia system that the track there could now be duplicated at about the same cost. The Kansas City Cable Company gives some interesting results of a test of its engines and machinery, from which I gather that with a total of 159·7 horse-power, no less than 119·06 H.-P. was required for the cable machinery, leaving only 40·64 H.-P. for cars and passengers. In other words, just 25 per cent. was available for actual traffic. This waste will strike electricians familiar with the high efficiency of dynamos and their transmission of power as extraordinary. But it is confirmed by a statement from Mr. C. B. Holmes, of Chicago, who says that his cable railway required for ordinary operation engines of 477 horse-power; that it took 389 horse-power to move the cable and machinery, and that 88 horse-power, or only 18½ per cent., was used for the propulsion of the cars at 9 miles an hour. Mr. W. W. Hanscom, in a careful review of the conditions applying to the cable lines of San Francisco, gives a total daily average percentage on the seven roads of 68 per cent. of power for moving the cable and 32 per cent. for the cars and passengers. Two miles of new double-track in San Francisco, fully equipped, have just cost $400,000.

I do not know that these figures call for comment, as those presented later on in regard to electricity will serve for purposes of comparison. But they may be supplemented by one or two observations. It is evident that there is an objectionable rigidity in the cable system and that it has narrow limits of applicability. A cable road, of whatever kind, needs a very large patronage. Mr. P. A. B. Widener, well known in connection with Philadelphia street railways, said last year: "To maintain a cable road you must have a certain amount of business in order to be self-supporting. It costs as much to run the cable for half a dozen cars as for half a hundred. Small roads, or feeders to the main line, are run more cheaply by horses." It will be remembered that great trouble was experienced in Philadelphia in rendering the cable system there operative last year. The assertion is made by those who should know that 12 miles, costing between $40,000 and $50,000 a mile, required $250,000 in repairs and renovation inside the twelve months, but as the *Ledger* put it philosophically at the the time of the breakdowns:—

"It is claimed that the delays and other annoyances that have been experienced by the company have been slight in comparison with those met with in Chicago when the cable road there was in its infancy." We New Yorkers and Brooklynites are more familiar with the mishaps on the East River Bridge, and from the arguments made here and elsewhere against cable roads we have learned that the cables wear out quickly, besides being ceaselessly noisy and requiring a conduit that must have such depth as to become an unhealthy drain or sewer.

We reach now, in the due course of our survey, the use of electricity as compared with horses or cables. You will, I believe, bear me out when I say that the confidence of electricians in the ability of electrical means to propel street cars is as strong as it could possibly be, and is, moreover, based on no small amount of work and experience. I might affirm that the general introduction of electric motors is now largely a question of coal bills. I might affirm that it has more and more resolved itself into a question of mechanics; and in both statements I should have your concurrence. I might broadly state that in Europe, where a large number of electric roads exist already, they are paying well and multiplying; and that such roads in this country had, some months ago, carried altogether over a million passengers, or a daily traffic of 3,000 passengers for a full running year, without any recorded injury to a single patron, while several new roads have of late gone into successful operation.

We have, in using electricity for street cars, the option of so many methods that the very flexibility of the application becomes a recommendation. We shall, perhaps, best spend our time in considering three or four of the leading methods, with incidental reference to the peculiarities of individual cases in each. I propose to take the third rail system, the overhead system, the conduit system, and the storage system, and, without any intention of invidious discrimination, to pick out, for the exemplification of each, some of the roads and cars that have been running or can be seen and tested.

Let us begin with the third rail system. The Daft road at Baltimore, now in its second year, has been so often described that full details are not here necessary, but it furnishes some interesting figures. The cost of electric power there against horse-power at $6.50 per car has been $4 per car per day, with an increase for the year of 83,986 passengers. The largest item in the expenses at Baltimore is coal at $3.50 a ton. Another third rail road, the Highland at Detroit, on which there are none of the grades and curves that rendered the Baltimore road expensive as to fuel, is in very successful operation. Like the Baltimore road, it has a

wheel for making contact, but, unlike it, has the third rail neatly sunken between planks. It runs out of the city for three miles. The car in use is the same as those on Broadway, this city. Mr. Frank Fisher, whose motor is used, informs me that on a recent Sunday, on a thirteen hour schedule, the road carried 5,500 passengers. The coal consumption was a little over 400 lbs. The coal—screenings—costs $1.25 a ton. The success has been so great as to lead to a development of plans matured for the increase of the service there and on a local road to be begun in the spring.

You will agree with me, I think, that third rail systems must be limited to a low electromotive force, and to suburban or rural districts. Even there they have a large opportunity.

Coming to the overhead conductor systems, the Van Depoele roads form an important group. These roads are now in operation at Detroit, Port Huron, Mich., Windsor, Can., Appleton, Wis., Montgomery, Ala, and Scranton, Pa. Mr. Van Depoele suspends his feeding conductor by side poles, or, as at Appleton and Scranton, has double wires, corresponding to the track, but immediately above it at a height of 18 or 20 feet. The little Windsor road, two miles long, with two cars, started in June, 1885, has paid for itself. I may mention that when I went on it last August, one evening I visited the generating station. It was deserted and in black darkness. I made the trip and then went back to the station. The darkness was blacker, and there still was no sign of attendance, but the 30 or 40 passengers each turn were none the wiser and none the worse. I don't approve such practice, however. The Appleton road, with five cars, is the first in this country run by water power, depending, and with great success, upon a pair or turbines that will develop 100 horse-power, and are now driving a 60 horse-power dynamo. The Montgomery road is notable as being a complete city system, including 10 miles of track. The Scranton road that started last week has two features of special interest. One is that in a city of about 50,000 or 60,000 inhabitants the use of the overhead conductor is allowed. Another is that the line is operated from the electric light station. The road is 2½ miles long, with 12 grades, mostly over 6 per cent. There are already in use two heavy Pullman cars, running at a speed of from 4 to 15 miles an hour. The current is conveyed by a conductor $\frac{3}{10}$ of an inch in diameter, the rails forming the return. A traveller with rollers and a flexible cable passes the current to the motor, which, it is worthy of notice, stands upon the front platform in sight of the driver. The electric light station is well satisfied with only $9 a day for running the 60 H.P. generator, and it is evident, therefore, that an increase of rolling stock will involve very little increase in cost of power. Here is a hint by which electric light men nearly everywhere might profit.

In the overhead conductor category should be included Mr. Daft's new roads at Los Angeles, Cal., one 3½ miles long and the other 2½ miles. A peculiarity is the placing of the motor in the centre of the car, occupying the room of but two passengers, and leaving both platforms clear.

The overhead bare conductor systems are also restricted to currents of low electromotive force. But they, as well as the third rail systems, do work it is impossible to perform remuneratively by cable, and which would often be beyond the range of horse or mule power on either philanthropic or business principles. Provided permission is obtainable for running the wires, the overhead conductor seems cheapest, if not best, for cities up to at least 50,000 population. I believe a double overhead conductor system well built should cost from $1,500 to $2,000 per mile. The single conductor is, of course, much cheaper.

There are in the United States about 40 cities with population above 50,000. In almost every one of these it would be necessary to resort to the electric conduit system, third on our list, unless the storage system be tried, or a combination of the two. At the present time, the outlook for electric railways with conduited mains is very favourable.

The first exemplification of a conduit system in this country was given by the Bentley-Knight Electric Railway Company in 1885 at Cleveland. A working section of their line can now be seen at the Rhode Island Locomotive Works, and as it illustrates in a striking manner the principles involved, I will touch on a few of the leading points now described for the first time. The conduit is made to resist the heaviest wear and strain of street traffic. The surface opening or slot is only $\frac{1}{8}$th of an inch wide, and the total width of metal at the street surface is but 3 inches. The conduit is kept clean by a broom of peculiar shape suspended from the car. This broom is said to have swept out in a single trip the accumulation from 12 hours constant snowing. At convenient points catchpans with sewer connections receive the sweepings and effect drainage. The two main conductors consist of channel iron connected by expansion joints and lined with a continuous strip of copper of sufficient size to carry the current with but small loss of energy. These conductors are fastened to the side walls of the conduit on insulators of vulcanised wood dipped in white lead. The insulators are strongly set in sockets in the cast-iron supporting yokes. Neither the traffic rails nor the conduit structure form any part of the electrical circuit. To provide for switching a movable tongue is pivoted at the point of branching, so as to rest on the top of the conduit and to be readily set to close either of the branch slots and direct the contact plow into the other. A corresponding conductor tongue within the conduit is moved at the same time. The contact plow for making connection consists of a flat frame hung from the car by transverse guides, on which it is free to slide the whole width of the car and extending thence down through the slot of the conduit. It is provided with a swivel joint, so as to adjust itself to all inequalities of road or conduit. This frame carries two flat steel insulated conductor cores, to the lower ends of which are attached by a spring hinge small contact shoes of chilled cast iron that slide along in contact with the two main conductors. At the upper ends are flexible connections leading to the motor. This plow can be inserted or withdrawn through the slot at will, the spring hinge allowing the contact shoes to straighten out into line with the conductor cores when the plow is pulled upward and the shoes strike the insulating lining with which the slot irons are provided. By no accident, therefore, can anything be left behind in the conduit to obstruct succeeding cars. The plow guides are hung on transverse axes, and are held in a vertical position by a spring catch that gives way when the plow meets an irresistible obstruction, and hence the plow is automatically thrown completely out of the conduit without injury, being also immediately replaceable. The contact shoes will stand weeks of wear and cost next to nothing. The frame of the plow has wearing guards of hardened steel wherever it can touch the edge of the conduit slot, and these are also readily renewed. Two plows are used on each contact for the sake of absolute reliability, and to prevent flashing at the contact. The connection between the wheels and motor consists of a system of gear wheels and connecting rods, the gears being deadened so as to be quite noiseless. The company makes a completely equipped steel-framed truck, with motor, &c., upon which can be placed any car body. These have a wheel base of 6 feet, a standard gauge of 4 feet 8½ inches, and can be used on curves with a radius of 45 feet. A motor of the Gramme type is used under the car. For long distances, the motors are in series, with current constant; for short distances, the motors are put in multiple arc, and a new form of resistance is used.

Such are the main features of the system. Of its eminent practicability there should be no doubt. The question again is one of expense, and I therefore give transcripts furnished me by Mr. R. W. Blackwell, of actual estimates submitted quite recently and now under consideration. This first is for the equipment of existing street railways in the City of New York, three miles, 1,440 feet, double track, minimum headway 1½ minutes, average speed seven miles per hour, running 24 hours per day, very heavy traffic, maximum grade three in 100.

Construction and Equipment.—Conduit and conductors, 34,560 feet, at $3, $103,680; motor trucks, 37 at $1,200, $44,400; 50 H.P. dynamos, 12 at $2,500, $30,000; steam power plant complete. $27,750; foundation, $5,000; engineering, $3,000—$213,830.

Annual Expense.—Coal, 14 tons per day, at $3, $15,330; engineer and assistant, at $2.50 and $2 per day, $1,642.50; firemen, three at $1.50 per day, $1,642.50; machinists, two at $2 per day, $1,460; total running expenses, $20,075. To which should be added interest on construction cost ($213,830) at 6 per cent., $12,829.80; and also depreciation of plant at 3 per cent., $6,414.90; total expense and charges, $39,319.70.

The second is for a down town cross-town road in the city of New York, greatest grade 1 in 12, double track; 12,660 feet conduit (extra heavy), at $4, $50,640; 20 motor trucks complete, at $1,200, $24,000; six 50 H.P. dynamos, at $2,500, $15,000; steam plant complete, $20,000; foundation, $2,000; engineering, $2,500—$114,140.

Of course, I do not present these figures as those upon which all authorities are agreed, but they have their value as being bids on actual work.

The conduit system of Mr. W. M. Schlesinger, in use for four months past by the Union Electric Company at Philadelphia, with a car running 9½ miles an hour, has noticeable peculiarities. It consists practically of two conduits, the upper of heavy channel iron for connection, the lower of wood or cement for drainage. To insulate the conductors, an angle iron is riveted to the top flange of the channel iron in such a manner that one of its flanges pointing downward parallel to the main side of the channel iron forms one side of the slot. In the inverted trough thus formed, the copper bar conductors are fastened, the contact being on the under side. Against the conductors pulling upward, rub or press springs, making a firm, close contact under control by means of a frame holding the springs. In Mr. Schlesinger's system, the motor is under the car between the axles, and geared to them by means of chains. The motors are intended to work in multiple arc.

There are other conduit systems, among which I may mention the Van Depoele used at Toronto, I believe, in 1884, at the Exposition. But my object is not so much to describe all the systems as to bring up main features and relative costs. I will, therefore, pass on to point out that whereas in the cable system, with its costly conduits, the available power for the cars and passengers reaches only about 25 per cent., in the electric conduit system, requiring for generators, conduit and conductors, &c., but half the outlay necessary on cable system, the net return of power, as you are well aware, reaches at the minimum from 50 to 60 per cent. Mr. G. W. Mansfield, who has had considerable experience with the Daft Company, puts it as being at least 56 per cent. I note, too, that with the use of the Holroyd-Smith conduit system, the Blackpool Road, England, has reported earnings of $1,735 in a week, with a total expense account of $225, running 2,760 miles and carrying 44,306 passengers.

A distinguishing feature of the conduit system is that it is the only one with which high potentials can be employed on the streets. With it, also, the power stations can be placed near ample water supply or where rents are low, or can each be given a section of road to operate.

I approach the next and last system on our list, that of storage,

with some degree of nervousness. In more than one quarter the man who comes out with a kind word for the secondary battery is set down as either a knave or a fool. I cannot see why he should be regarded as either, although he may perhaps be more than ordinarily sanguine and hopeful. I have myself ridden very comfortably in a street car propelled by storage batteries, so that I know the thing can be done, and I understand that storage is to be extensively used at an early date by the North Metropolitan Tramway Company in London. At Antwerp, in 1885, after six months' competition with four other cars using either steam or compressed air, the Julien electric storage car took the first prize, awarded by a jury of well-known experts. There were in all twenty-three points of comparison. The Julien car has since been tried in Hamburg, and another has been in operation on the Eighth Avenue line in this city. Mr. Widener, of the Philadelphia cable line, has travelled on it and is to try it, being very favourably impressed. But as he remarked publicly: "The question is as to the cost of maintenance of the cars and the furnishing of motive power." It will be admitted that there are advantages in having each car an independent unit, offsetting the disadvantage of carrying the dead weight of batteries; and that single cars on any road can be taken in hand for change, so that existing rolling stock can be progressively adapted to the new conditions. This involves a smaller initial outlay and gives opportunity to train the present force in its unfamiliar though simple duties. Now, regarding first cost—I have never seen any figures as to the expense of an equipment of a car with storage batteries. It has been said that two sets for an ordinary street car would cost about $1,500. That seems high. The Julien Company states that the cost of the horses for a car more than covers the initial outlay of the change, and I believe the firm estimate is also made by the company of a total daily running expense of not to exceed $5 per car in cities on heavy traffic. As to life of the batteries, those in the Hamburg Julien car have now been in daily use since April, and they show by diagram of test a return of 71 per cent. of the power with which they are charged. The car is running on regular daily service. In respect to American storage batteries, it may be mentioned that the Electrical Accumulator Company, whose officers have a high standing in electrical circles, guarantee two years' life for its new battery and an 80 per cent. return of power. The criticism has been made that ordinarily 20 per cent. of the stored energy is retained on each emission, but obviously that is no loss, forming simply 20 per cent. of the succeeding charge.

Putting it broadly, the storage system, in spite of its various conversions of energy, has a superiority of at least 25 per cent. over cables. Some of you will put it far higher, but, as I have said, in the absence of the data of prolonged work, I prefer to put it low.

I think we shall see a number of efforts shortly made in the direction of using secondary batteries for regular work on street cars, and the results will merit our most careful study. There are, moreover, some ingenious propositions for combining the conduit and storage systems, so as to enjoy the benefits of both. Mr. J. M. Pendleton has described a plan of his of this nature, and Mr. Elias Reis, of Baltimore, has also carefully elaborated such a system, in which storage plays an important part.

Here, then, illustrated in a variety of ways and by numerous examples, we have a comparison of electricity with other power for propelling street cars, and an idea is given, very imperfectly, of the wide range of choice that electricity itself offers as to methods and means. Much of what has been said has its direct and favourable bearing on elevated railway traction, as well as on that for underground railways, but the time will not permit me to pursue the subject any further. Many points of discussion arise as to the connection of the car axles with the motor; the use of independent motor cars or of motors on the passenger cars; the types of motors and of conduits or conductors; the potential that is safe under certain conditions, the methods of regulating motor speed, the use of resistances; but all these and others I may leave to you, many of whom are doing practical and creditable work in this field, and who by thus "hitching your wagon to a star," have shown that street cars, if run by electricity, may yet be brought up to the most advanced notions of humanity, comfort, convenience, and economy.

All that remains is to press onward and occupy the pre-empted territory that awaits us. As Emerson says:—"Our duty is plainly not to throw ourselves across the track, not to block improvement, not to sit still till we are stone; but to watch the uprise of successive mornings and to conspire with the new works of new days." This sentiment may surely be appropriated by modern electricians, who every year put their skill to some severer test and every year win fresh triumphs. In beginning this street railway work, we may count on a large and profitable travel for some time to come, through the mere novelty of the thing, but as the art improves it will more and more manifest its right to street railway propulsion on the strictest business principles, as well as on every other ground of merit.

Nipher's Theory of Magnetic Measurements.—We are informed by Messrs. Whittaker and Co. that they have acquired from Mr. D. Van. Nostraud, of New York, the right of sale in England of this work, a review of which appeared in our impression of December 10th.

INCANDESCENT LAMP PATENTS.

COURT OF APPEAL, HIGH COURT OF JUSTICE.

(*Before* Lords Justices COTTON, BOWEN and FRY.)

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

THIS case was resumed on Friday, the 17th inst., the ATTORNEY-GENERAL (Sir Richard Webster, Q.C., M.P.) continuing his argument for the respondents, the plaintiff company. He said, upon the cases cited by Sir Horace Davey, that there was a broad line of distinction between a new commercial article, that was to say, a new manufacture in the sense of being a concrete product, and a new mode of applying an old machine or old ingredient. It was conceded by every witness that whereas prior to the date of the publication of the complete specification of Edison, incandescent lamps were absolute failures and were commercially unknown, after that date they were uniformly and universally a success. It was admitted on the part of the defendants that the specification contained perfectly sufficient instructions to enable a competent workman to make the incandescent lamp therein described. Everything that had happened since the date of the specification was in the shape of improvement, and it was not a different lamp that was afterwards described. Up to the time of Edison, the course of discovery had been leading people wrong for twenty or thirty years. It had been known for a considerable time that carbon would act as a conductor or illuminating medium in an electric lamp, but it had never entered into the mind of anybody that they could rely for practical electric lighting upon a thing so thin and fragile, and yet having the properties which made it successful, as a carbon filament, which, if it were taken out of the lamp, would fall to pieces in the hand, so exceedingly delicate was it. The latest exponents, including Mr. Swan himself, had proceeded on lines which showed that they utterly misconceived the real nature of the secret. Swan took a stick of carbon, a thing rigid in itself, and tried to work it down to a sufficiently small cross-section to give the proper resistance. He (the Attorney-General) ventured to say that he would never have succeeded in whittling down his pencil to a size which would have made it a practicable conductor for an incandescent lamp. No diminution of sectional area would produce Edison's invention, starting from the point of Swan. What they had to consider in approaching this question was the previous knowledge of people on the subject. The whole of that knowledge might be divided into two classes: first, the knowledge of those who, having got the carbon in the shape of a powder or pulverised substance, built up a bridge in which carbon formed the conducting element; and secondly, the knowledge of those who took a stick of carbon and endeavoured to work it down to something that would act effectively. Edison had in his specification described that which was absolutely new, and in terms that no workman could mistake. He was not there to say whether his clients could make as good a lamp as Messrs. Woodhouse and Rawson; possibly the latter might at this day make a better lamp than the company. His point was, and he challenged his learned friends to put their case higher than that, that they had only made a better preparation of one of the elements of the combination described in the second claim of Edison's specification.

Mr. JUSTICE FRY asked whether it was contended that every carbon filament would be an efficient filament for the purposes of Edison's lamp.

The ATTORNEY-GENERAL said the point was not raised in the court below. Lamps made from every single description and mode in the specification were in the court for the purpose of being put in, but because of the admission made that the specification was sufficient they were not put in.

Mr. JUSTICE FRY said that was not the exact point. Supposing he agreed with Mr. Justice Butt in regard to the narrow construction of the claim and held it to mean carbon filaments possessing certain qualities. That was what he called a restrained construction. What was passing in his mind was this: the Attorney-General had been insisting, as he gathered, upon an unrestrained construction.

The ATTORNEY-GENERAL said he had never said unrestrained construction. He must not have an argument put upon him by his learned friends which he did not use. Nowhere had he suggested anything more than a thing of a filamentary character carbonised and possessing the qualities of flexibility and resiliency. Such a thing, he had proved by the evidence of Dr. Hopkinson and Sir Frederick Bramwell, and it was admitted, was the filament in the defendants' lamp; it was a filament made into filamentary form before it was carbonised.

Sir HORACE DAVEY: I have never admitted anything of the sort, and there is not a line in the evidence to justify such a statement.

The ATTORNEY-GENERAL said this was the first time any of the counsel in the case had suggested that it was not so. He would show their lordships what the evidence was. The Attorney-General then read certain passages upon the question of the filament in the defendants' lamp from the evidence of Dr. Hopkinson.

Mr. JUSTICE FRY: I am not sure even now that I quite follow what your opinion of a filament really is. You say a filament within the meaning of the second claim must be one which must have a resistance of from 100 to 500 ohms, and be of the size of seven one-thousandths of an inch in thickness?

The ATTORNEY-GENERAL: That is the character, my lord; that would be such a filament as is described.

Mr. JUSTICE FRY: You connote the word filament in that?

The ATTORNEY-GENERAL: That would not be necessary for every filament. I am putting there [in the question to the witness] what we believe is undoubtedly a specimen of a filamentary class. I am putting it, "Do you find anything in the description like that?" I was not speaking of the resistance of the lamp. Continuing, he said he was referring to the character of a filament, and speaking to an electrician who thoroughly understood that the resistance of the lamp depended upon the length and the size of the filament through which the current was passing. He knew the temptation in the Court of Appeal to shift the ground on which the case was fought, and that there was a tendency to fall into that course unconsciously. But he was anxious to avoid so doing, and he submitted that what the defendants were striving originally to say was that what was described in Mr. Edison's specification was not good subject matter, because they could find in some of the anticipations something which would enable a person to make the same combination. Their lordships had before them two lamps which were admittedly of Messrs. Woodhouse and Rawson's manufacture. The larger of those lamps might be of 300 or 400 ohms resistance; but if it was wanted to make a lamp for a lady's hair it would simply be necessary to cut off an inch of the filament in that lamp and make it into a smaller lamp. This would be a lamp of lower resistance, and the alleged great differences in the resistance of the various sizes of lamps made by Messrs. Woodhouse and Rawson were merely differences in the length of the filaments. He submitted that you could not keep yourself outside an infringement by doing only a certain part of what the patentee described. He (the Attorney-General) had been grappling with the suggestion that there was sufficient prior knowledge to prevent a claim to such a combination as was described from being upheld. This point bore directly upon a proposition which had been put to him by Lord Justice Cotton, namely, that he had to consider whether that combination could be the subject matter of a patent, having regard to what had gone before. His respectful reply to his lordship was that there must be found in those anticipations a direction enabling a person to make the thing described in the plaintiff's specification, and Dr. Odling, the defendants' witness had admitted that there was no such direction in any single one of the alleged anticipations. Dr. Odling was re-examined, and he believed he was correct in saying that there was not a single attempt to qualify, to restore or to take away from. or to affect in any way the answers given, or, rather, the admissions made, by Dr. Odling respecting what was the existing state of knowledge. If their lordships upon that evidence said as a matter of law that the combination was not subject matter, all he could say was that they would be laying down for the first time a rule which would cut at the root of the validity of the most useful patent which had been taken out for the last fifty years, and a rule which—was contrary to a great many decisions of the House of Lords. Proceeding to deal with the question of the period of shaping the filament, the Attorney-General said, Sir Frederick Bramwell stated his belief that the filament in the alleged infringement was shaped or cut out before being carbonised. It was impossible to say with absolute positiveness, without destroying the specimen, and that nobody was justified in doing. Dr. Frankland, Dr. Odling, Mr. Jamieson and Mr. Rawson, were all called, they all had Swan's lamp in their hands, and not one of them said Sir Frederick Bramwell was incorrect. It was never suggested that he was in the Court below. If they intended to suggest, directly or indirectly, that the plaintiffs were wholly misinformed, at least the defendants ought to have called their attention to it. In conclusion, he submitted that there was no case in which the court, after it had been found that a thing was new and useful, had said as a matter of law that there was so little change from what had gone before, that it could not be subject matter of letters patent, and when the thing was an absolutely new commercial article, it would simply wipe out a very large portion of the patent law of this country if such a principle were to be enunciated.

On Saturday, Mr. ASTON, in the absence of the Attorney-General, proceeded with the case for the respondents, and cited a number of decisions in cases which he held were analogous to this, and which bore upon the construction of the patent law.

Sir HORACE DAVEY, replying for the appellants, said his learned friend, the Attorney General, and to a certain extent Mr. Aston also, had attached great importance—far too much importance, in his judgment—to the fact, if it was a fact, that it was proved at the trial that a workman could make a lamp from the description in the specification. The way in which the Attorney-General used the argument was this: inasmuch as the sufficient specification has been either proved or admitted, it does not matter which, for the purposes of argument, *ergo*, you cannot quarrel with the wideness of the second claim. That seemed to him (Sir Horace) to involve a fallacy of language. Sufficiency of specification might mean two totally different things; it might mean either that there was a sufficient description in the specification to enable a man to make a lamp which would be within the claim, or it might mean that there was a sufficient description in the body of the specification of that which was claimed as the patentee's invention in the claiming clauses. He was not prepared, and he did not desire to dispute that it was proved at the trial that a workman could, taking the description in the specification, make a lamp which would be a lamp within the claiming clauses. At the same time it was disputed, and Mr. Jamieson gave some evidence about it, that there was a sufficient description to enable a man to carbonise an ordinary fibrous vegetable material. Sir Frederick Bramwell said the statement that the material was to be carbonised in a closed chamber was a sufficient direction. But that was something totally different from what they (the defendants) alleged and which formed nine-tenths of their argument before the Court below. What they denied was this, that, assuming the second claim to bear a wider construction than that which had been put upon it by the learned judge and which was adopted by his learned friends, there was any sufficient description of where the filament was to be found within the four corners of the specification; or in other words, what they denied was that the patentee, in the language of the Act of Parliament which was then the Act relating to patents, the Act of 1852, had particularly described and ascertained the nature of his invention as claimed in his claiming clauses. The specification might describe in the most careful and minute manner a process by which a workman could produce a patented article, but if the claiming clauses claimed as the patented invention something which was not found within the four corners of the specification, it was not particularly described. The difficulty which his learned friends had experienced in finding an intelligible meaning for the words of the specification was indicated by the different views which they put forward. Mr. Aston said a carbon filament within the second claim meant a carbon conductor of small cross-section and of great length, possessing such an amount of flexibility and resiliency as would allow of its expansion under the influence of heat. The first observation he would make upon that was that it was not necessary that high resistance should enter into a carbon filament. That observation applied both to his learned friend's argument and to the claim itself. The first claim having spoken of a carbon filament of high resistance, the second claim spoke only of a carbon filament, and was not therefore confined to a filament of high resistance. With regard to flexibility, he repeated that it was impossible for his learned friend to find from beginning to end of the specification any passage in which flexibility was spoken of as one of the qualities, differentia, and characteristics of a carbon filament when it was prepared for use in a lamp. It was undoubtedly true that there was one mention of flexibility; but in that instance the mind was led away from the idea of flexibility being an attribute or a desirable characteristic of the carbon conductor; in fact, you were actually told that provision was made for its stiffness. Dr. Hopkinson showed that the conditions which Mr. Aston laid down did not form any part of the definition of a carbon filament as used by Mr. Edison. His answer applied to flexibility and resiliency and applied also to cross-section. What amount of cross-section, what amount of length, would make a filament? Sir Frederick Bramwell said it was a mere matter of degree; you could not draw the line.

Sir HORACE DAVEY continued to address the Court on Monday, in reply to the arguments of the Attorney-General and Mr. Aston. Speaking of the alleged failure of the early Swan's lamp, he said that was due to an overcharge of the current and not to any inherent defect. That Mr. Swan did produce a practical lamp was proved by the fact that one was kept alight through the lecture which he delivered at Newcastle, and was put out at the end of the lecture. Whatever importance was to be attached to the question whether Swan's lamp was a successful lamp or not, in the sense of being a good incandescent lamp, the evidence, when properly understood, was all one way. In dealing with the question of infringement, Sir Horace Davey said he would bear in mind what Lord Justice Cotton was good enough to say on the previous morning, that assuming that Edison's patent did not bear the large construction which the Attorney-General claimed for it, but bore some smaller construction, was there or was there not evidence of infringement? His learned friends, as far as he understood, did not raise the question which they raised in the court below and pressed upon the learned Judge, that there was evidence that Woodhouse and Rawson's lamp was an infringement of the first claim; or in other words they now did not ask their lordships to differ from the learned judge, who held that there was no evidence to show that Woodhouse and Rawson's lamp was "made as described." It was said that the defendant's lamps were infringements of Edison's lamps first because they contained a burner which was of small cross-section compared with its length, and had a certain amount of elasticity and resiliency. He had already said, and would repeat, that if that were the true construction of Edison's patent, then he must plead guilty, because undoubtedly the burners of Woodhouse and Rawson had a small cross-section in comparison with their length, and they had a certain varying amount of flexibility and resilience; but he had already addressed their lordships for the purpose of showing why that could not be the construction of Edison's patent, and why, if it were the construction, Edison's patent was too large or too vague, or did not sufficiently ascertain and describe his invention. Then it was said that it was an infringement because there was evidence to show that the carbon filament or burner assumed its filamentary character before it was carbonised. He could only say that he was not aware of the evidence upon which his learned friends relied, except that Sir Bramwell said he did not know any other mode by which it could be made. It was not wonderful that even Sir Frederick Bramwell was not omniscient, and he had yet to learn that the fact that even so eminent a man as Sir Frederick was unaware of what was said to be a secret process was any evidence that that process did not exist. Mr. Aston, in the course of argu-

ment, himself indicated a mode in which these filaments might have been made, some mode with which he was acquainted, perhaps. Mr. Aston put the case hypothetically, and only for the purpose of illustration; but he (Sir Horace) called his learned friend as a witness in his favour, to show that because Sir Frederick Bramwell did not know of a mode was not evidence that there was no mode.

Lord JUSTICE COTTON asked what Sir Horace had to say with reference to the last sentences in Mr. Rawson's evidence, if he repudiated the suggestion that the filament was made into a filament before it was carbonised.

Sir HORACE DAVEY resuming, said if his learned friends said it was assumed in the court below that the defendant's filaments were shaped before they were carbonised, he was perfectly certain that nothing which fell from himself, or from Mr. Charles or Mr. Macrory, who were with him, warranted any such assumption. They said that Mr. Justice Butt came to the conclusion that the filament assumed its filamentary character before it was carbonised, but although he had read through the learned judge's judgment again he could not find anything of the kind. Then they pointed to Mr. Rawson's evidence, and said Mr. Rawson proved the fact. But Mr. Rawson proved nothing of the kind. He ventured to say that it was entirely to misunderstand Mr. Rawson's evidence to say that he did so; he went farther than that, and said that if his learned friends intended to rely upon this point as against Mr. Rawson, the least they could have done would have been to ask him the question straight out, "Do your carbon conductors assume their filamentary character before they are converted into carbon?" They might say they did not desire to pry into Mr. Rawson's secrets. He gave them full credit for their desire to respect the sanctity of Mr. Rawson's manufacture. At the same time, it would not have been interfering with that sanctity or unduly interfering with Mr. Rawson's secret, if they intended to rely upon this point, to say: "This is a crucial test of whether you infringe or not." Mr. Rawson, of course, might have declined to answer; but that did not relieve them of responsibility for not putting the question to him. In the final clause of Mr. Rawson's evidence, he would admit, there was an ambiguous reference to carbonising. But he thought that reference was perfectly well understood at the time, although its meaning could not be so clear to their lordships. His learned friends were not entitled on a vital question to draw an inference from an ambiguous reply, when it was open to them to put a direct question. It was important, in order to understand the meaning of Mr. Rawson's last answers, to see what was being dealt with at the time they were given. Having read the passages, Sir Horace said what the witness was speaking of was not the converting the filament into carbon, but a subsequent process, similar to Sidot's and to one described by Lane-Fox, of depositing carbon after the filament was formed and after it was placed in the lamp, the process of "flashing," in fact. If his learned friends had nothing better with which to fasten the charge of infringement upon Mr. Rawson than this ambiguous answer, it was their duty to have cleared up the point and to have asked the question directly.

Mr. ASTON, upon the conclusion of Sir Horace Davey's address, endeavoured to get a hearing upon a new authority which he said had been imported into the case, the case of Brush *v.* Fox, but as he said he could not speak upon that case without reference to the specification, their lordships declined to hear him.

Lord JUSTICE COTTON intimated that judgment would be reserved.

NOTES.

Electric Lighting of Underground Trains.—For a week past two trains, which pass over the section of the line between Queen Street and College Street stations, Glasgow, have been lighted by electricity, and the question of automatically extinguishing the light on the train issuing into the open air has been solved by the system which we described in our issue of December 3rd. The invention is that of Mr. Thomas P. Carswell, assistant engineer to the North British Company; but at present his system has only been applied from Queen Street to College Street, a distance of a little over half a mile, but it will soon be complete over the whole of the Underground Railway. The rail from Queen Street to Charing Cross—a mile and a quarter—will be finished this month. The light is very good, and small print can easily be read by it. The lamps are very neat in shape, and are screwed by a wooden base to the roof of the carriage. The exhausted bulb is enclosed in a larger cylindrical glass, and the wires are invisible. Under this system it is a matter of indifference how many or how frequently trains pass through the tunnel: they all get their light alike, as the central rail is constantly connected with a dynamo of the Crompton self-regulating type, which already supplies a current for lighting the Queen Street Station goods' shed. When the rail has been completed, and all the regular trains on this railway have been fitted up, passengers will have little cause to complain of the darkness of the Underground Railway.

Liskeard and the Electric Light.—At last week's meeting of the Liskeard Town Council considerable discussion was indulged in, regarding the recommendation recently made by an influential meeting of inhabitants that the Corporation should take steps with the view of adopting electricity for public lighting purposes. The resolution in question having been entered on the minutes, Mr. Rogers moved, "That with the view of the substitution of electricity for gas for a portion of the public lighting of Liskeard, the Town Clerk ascertain from Messrs. Laing, Wharton and Down whether they are disposed to contract for the supply and maintenance of 18 arc lamps, or any larger number, and, if so, on what terms per lamp." The motion having been seconded, an opinion was expressed by Mr. Parker to the effect that electricity would prove cheaper than gas, but that other firms should also be asked to tender. The Town Clerk intimated that he had been written to by another firm on the subject, enquiring whether they would be permitted to tender. Several members pointed out the undesirability of obtaining quotations as to price unless they had really made up their minds to adopt the improvement. The Mayor: Until we get an estimate we cannot say what we shall do. Ultimately, Mr. Rogers's resolution was carried, and it was afterwards decided that other firms should also be invited to forward tenders.

Electric Lighting at Okehampton.—Mr. Henry Green, of Okehampton, has lately introduced the electric light into his business establishment, provision being made for supplying 40 20-candle incandescent lamps. The motive power required for the working of the dynamo is obtained from a turbine, used for other purposes in connection with the business.

Electric Lighting in Germany.—Several large schemes are on foot, *Industries* states, of electric lighting in Germany. Messrs. Siemens and Halske, of Berlin, are establishing a public company in Amsterdam, for the purpose of erecting central stations and supplying the electric light to towns in Holland. Herr Schuckert, of Nurnberg, is lighting up the harbour in Bremen, and the Municipality of Leipzig are organising the supply of electric light from a central station in that town, which will practically be a monopoly in the hands of the municipality.

The Electric Light in Theatres.—Mr. F. Ross, in a paper which he recently read before the Vienna Society of Electricians, mentioned that there are at present about twenty theatres in Germany and Austria lighted by electricity throughout.

Electric Lighting on Railways.—It is stated that with the beginning of the new year the London, Brighton and South Coast Railway Company intends to apply the electric light experimentally to a number of carriages side by side with an equal number lighted by colza oil. Each of the first-named carriages will be provided with one 10-C.P. lamp, placed in such a way as to avoid shadows, the locomotive to supply the generating power. It is further stated that the plan adopted is that of the Railway Electrical Contractors, in which the dynamo is driven from the axle of the guard's van by the momentum of the train, and charges the accumulators while the train is in motion. It is not expected at present that economy will be effected, but the light will be better than that furnished by oil lamps even of the most approved type; and by-and-bye the cost will no doubt be gradually reduced.

Workshop Lighting.—The Gloucester Wagon Company invites tenders for the most economical mode of lighting a new workshop now approaching completion. Proposals may be made for lighting by gas, electricity, or otherwise, and may include also methods applicable to raising steam in boilers, and to heating iron rivets. Proposals to be delivered by January 18th to the general manager, from whom further particulars can be ascertained.

Temporary Lighting.—On the occasion of a bazaar held at Thrapston, October 14th, 15th, 16th and 18th, the Corn Exchange was illuminated by about 60 incandescent lamps, the stalls being arranged in the style of a gipsy encampment; the interiors were lighted by separate incandescent lamps, the whole being driven by a portable engine situated 100 yards distant.

At Uppingham, on October 27th, the occasion of a large Conservative demonstration, the tents and approaches were brilliantly illuminated by about 200 incandescent lamps, driven by two portable engines about 50 yards distant.

A bazaar, under the auspices of the School of Art, was held on December 8th, 9th and 10th, in the Drill Hall, Peterborough, which was effectively lighted by 100 incandescent lamps, a cluster of 20 40-C.P. lamps being used to light the entrance.

These installations were all carried out by Messrs. E. Storey and Son, of Oundle.

The Electric Light and Torpedo Defence.—A fleet circular has just been issued by the Admiralty, directing vessels of the Royal Navy to be practised at night, twice a year, with their quick-firing and machine guns and with case shot from heavy ordnance. Theoretically, the ships, which are to be underway and steaming at a speed of no less than six or seven knots, will be engaged in repelling a torpedo attack. A target rising out of the water six feet will be erected in the shape of a cross, and in discovering this the electric search lights will be called into requisition. Where, however, electricity is not available, a buoy displaying a light will be stationed close by, so as to afford the marksmen some approximate idea of the locality of the target. Each commander will use his own discretion as to marking the sights of his guns until the use of electricity has enabled them to be properly distinguished. The target will never be less than 500 yards distant.

Thief and Fire Detector.—The apparatus shown on p. 612 has been introduced to our notice by Mr. James Fyfe. We do not think that such systems find much favour in this country, but much depends upon the manner in which they are introduced.

Continuous Current Transformers.—What will Messrs. Paris and Scott think of the article on p. 613 of this week's REVIEW? We have ourselves experimented many times 10 years ago with a Gramme machine, manufactured by the now defunct British Telegraph Manufactory, having a double-wound armature by which any current supplied thereto could be transformed into something essentially different.

Electrical Journalism.—The *Electrical World*, of New York, has published a neat little pamphlet, containing interesting particulars of the growth of the *World* and its predecessor, *The Operator*, during a period of nearly 13 years. The comparative statistics presented at the end of the volume, however, are not particularly valuable, as it is idle to compare an enormous country like America with the limited space and enterprise existing in England.

An Electrical Metronome.—An electrical metronome has been established at the Paris Opera House, which enables the *chef d'orchestre* to conduct choruses at any distance from his chair. The working is said to be very satisfactory, and the effect really admirable.

The Telephone and the Stage.—We are asked to state that every detail of the installation for the transmission of the opera at Lisbon, which we referred to last week, is on a system invented by the manager of the Edison Gower-Bell Telephone Company, Mr. Alan Danvers. The method of installation in the Opera House, we are informed, is entirely novel.

New Postal Telegraph Office for Truro.—Owing to the increase of business consequent on the rising importance of Truro, a new postal telegraph office has been opened in that town, the building being one of the finest of the kind in the South of England. Ample accommodation is provided for the public, who will now enjoy increased telegraphic facilities. The instrument room is situated on the top floor, and communicates with the battery room. From the ground floor to the instrument room and thence to the battery room, there is fixed a pitch pine casing for the whole of the wires, this being carried out on a new principle. The opening of the new palace has, of course, been celebrated by a dinner.

Personal.—Mr. Thomas C. Martin, who has for about 17 years been connected with the Post Office Engineer's Department at Edinburgh, has been appointed assistant-editor of the new Edinburgh newspaper, *The Scottish Leader*.

Mr. Harold B. Dixon, M.A., F.R.S., Fellow of Balliol College, Oxford, who carried out the photometrical tests in connection with the recent experiments on lighthouse illuminants conducted at the South Foreland, has been appointed Professor of Chemistry and Director of the Chemical Laboratories in Owens College—the Victoria University—Manchester.

An Electric Launch in France.—The Société des Forges et Chantiers de la Méditerranè has placed at the disposal of the French Navy, for experimental purposes, a launch 30 feet long, which is propelled by an electric motor fed from accumulators. Formerly the launch was propelled by steam; but the boiler and engine have been removed, and the electric plant, which is of equal weight, has been substituted. The power developed by the motor is 17 H.P., which is a little more than the indicated power of the former engine. Preliminary trials, which were undertaken by Captain Krebs (of ballooning fame), proved very successful.

Soldering by Electricity.—It is said that Messrs. Rothschild have bought the French patents for this invention, and experiments are now being made at the Creil Works, especially with a view to welding iron.

Gas Explosion.—An explosion caused by a leakage of gas occasioned great destruction at the General Post Office at North Shields a few days ago. The roof was blown off, heavy coping-stones were thrown down on to the pavement, back and front, and the whole structure seemed to have been twisted out of shape, while internally the woodwork, ceiling, and furnishing were totally smashed and charred. Two persons were seriously injured and were removed to an infirmary.

The National Telephone Company, Limited.—The staff and friends of the Yorkshire and Nottingham districts of the National Telephone Company, Limited, held their Annual Assembly in the Albert Hall, Leeds, on Friday evening, the 17th inst. Dancing commenced about 8.30 to the strains of Waithman's band, and the first part of an excellently arranged programme was completed about 11.30, when an adjournment was made for supper. Mr. Josh. C. Chambers, the company's general manager, presided over the elegantly-arranged tables in the unavoidable absence of Colonel R. Raynsford Jackson, the chairman of the company. After an excellent collation served by Mr. Parker of the Grand Restaurant, a move was again made for the large hall, where dancing was resumed and kept up until an early hour. The managers of the various centres interested acted very efficiently as stewards.

Electricity at the Jubilee Exhibitions.—The Lighting Committee of the forthcoming Exhibition at Newcastle has decided to give the contract for lighting the whole of the buildings with the electric light, the contract to include engines and all appliances, to Messrs. Clark, Chapman, Parsons & Co.; the contract for lighting the Art galleries to Messrs. J. H. Holmes & Co., of Newcastle; and the contract for lighting a portion of the gardens to Messrs. Paris and Scott. The 11th of May is the day fixed for the opening. A special building is being erected at Manchester for the dynamos and engines required for lighting the Jubilee Exhibition in that city.

Cable Repair.—The tug *Anglia* has completed the repairs to the Land's-end shore end of one of the Western Union telegraph cables, which was broken a few miles from the shore.

Wind and Water Power.—A correspondent writes:—"I saw in the ELECTRICAL REVIEW of December 10th, an article on the use of secondary batteries in conjunction with dynamos. I am purely a novice in these matters, but it some time ago occurred to me as I saw so many mills with water power running by their doors unused, that if a dynamo, of say half the size necessary to light the mill, could be employed with a secondary battery of sufficient capacity fitted with an apparatus (I do not know whether such has ever been invented) which, as soon as it was fully charged, would throw the dynamo out of gear with the water motor, and when it, so to speak, began to empty, start the dynamo again—that here would be a very economical source of illumination. Possibly a dynamo of less than half the size would do, as it could run night and day, and the light would only be required for a few hours. Such an arrangement would need practically no attention, and should cost next to nothing when once the plant was laid down. Might not such a system be applied to dwelling houses, &c., by utilising wind power? I understand that greatly improved wind motors are now to be had."

Electricity at the Paris Exhibition of Sciences and Industrial Arts.—The "Jury superieur" of the Exhibition of Sciences and Industrial Arts, Paris, has awarded the following prizes (among others) to the exhibitors in classes 21 and 22 (Electricity, Telegraphy, and Telephony): — Diplômes d'honneurs—to the Banque d' Escompte, for Gaulard and Gibbs' electric transformers, which have partly contributed to the lighting of the Palais de l' Industrie, and have been otherwise applied for some months in France, at Tours, and abroad in several towns—to the Compagnie Edison, for the whole of its exhibits, machines and lamps for electric lighting purposes; a dynamo worked by a gas engine; a Pieper regulator; incandescence lamps — to M. M. Thomson-Houston, for their electric machine established on original principles, and for their regulators, which have worked during the whole of the Exhibition—to M. Julien, for his application of accumulators to electric tramways, experimentally tried at Antwerp, and also at the Palais de l' Industrie, where a number of interesting observations were made — to M. Lodyguine (and his associate) for their studies and inventions relating to incandescence lamps. Gold medals —to M. Pulsford (representative) for the Phœnix dynamo machine for good construction—to the Société Anonyme d' Electricité, for their electric light installation, machines and lamps of M. Anatole Gerard—to MM. Woodhouse and Rawson, for their incandescence lamps and their models of electric lighting apparatus. The total number of prizes given were 7 Diplôme d' honneur, 6 gold medals, 7 silver-gilt medals, 13 silver medals, 12 bronze medals, and 7 honourable mentions.

The Edison Incandescent Lamp Patents. — The Edison Company of New York has recently issued a pamphlet setting forth at length the claims of priority on behalf of Mr. Edison to the essential features of the modern incandescent electric lamp. The contents of this pamphlet are reproduced in the December issue of the New York *Electrician and Electrical Engineer*. There are seven full-sized illustrations of lamps which are supposed to infringe the Edison claims in a number of particulars. Their names are as follows:—The Weston, Brush-Swan, Westinghouse (2), Bernstein, Mather, and Sawyer-Man. Twelve special patents of the company are alluded to, the features included in which enter into the manufacture of the Edison lamp, but the complete list of patents owned by the Edison Company shows the number to be 266, all of them relating to electric lighting.

Electric Street Cars.—The editor of the New York *Electrical World* with his usual courtesy has sent us advance proofs of a paper read by Mr. T. C. Martin on the 7th inst., before the American Institute of Electrical Engineers. This is about the first attempt made in the States to arrive at some sort of definite idea regarding the cost of the various systems. Mr. Martin in the course of his remarks says, "I have never seen any figures as to the expense of equipment of a car with storage batteries." We can therefore only conclude that he has never read the admirable articles on "Electric Locomotion," by Mr. A. Reckenzaun, which have from time to time appeared in the REVIEW.

A Year's Work.—Messrs. Crompton during the past year have been engaged in the manufacture of an increased number of dynamo machines, the greater number of which have been disposed of through their English and Foreign agents. They themselves have confined their installation work to several large installations, the first of which is the lighting of the Tilbury Docks, the order for which they received on January 1st, and the work was completed with the exception of a few additions by July 1st. This installation, which is very complete of its kind, comprises about 1,300 incandescent lamps, and 100 arc lamps, dispersed over a very wide area. They have manufactured a large quantity of apparatus for the Imperial and Continental Gas Association to be used for the lighting of the Grand Opera and the various theatres in Vienna. The boilers, steam engines and dynamos for this work are among the largest that have ever yet been manufactured for electric light work, and the economical efficiency as reported in these columns has been exceptionally high. The enormous volume of current to be dealt with from the accumulators used in the Grand Opera necessitated an entirely new departure in the design of the switch boards and regulating apparatus used. We hope at some future time to be able to illustrate these for the benefit of our readers. Messrs. Crompton, also, in combination with Messrs. Willans & Robinson of Thames Ditton, have manufactured 17 combined sets of engines and dynamos for torpedo boat search lights for the Admiralty. Among interesting installations may be mentioned the central station they are putting down at Kensington Court for the supply of electric light through the houses of the surrounding district. They are also completing a contract for the Argentine Railway for the lighting of the railway sidings and walls at Rosario. They have latterly given much attention to the manufacture of economical motors for transmission of power direct to machinery, cranes, &c.

Australasian Telegrams.—The Hon. F. T. Durham, Postmaster-General for Victoria, in a recent statement in the Legislative Assembly, respecting the transit of the Australasian mails, stated that the Eastern Extension Telegraph Company had suggested a 4s. tariff and a subsidy of £75,000, or a 2s. 6d. tariff and a subsidy of £100,000.

Telegraphic Communication in Canada.—Canseau, Nova Scotia, was on Sunday put in direct circuit with New Westminster, British Columbia, an unbroken land line of 4,600 miles, over the wires of the Canadian Pacific Railway.

"Twigging" the Red Light.—At a meeting of the Portsmouth Town Council last week, a motion was submitted, but afterwards withdrawn, favourable to the purchase by the corporation of the gas and water works. There was a general consensus of opinion as to the undesirability of the council engaging in such a speculation as that of supplying gas to the community, it being more than possible that in the near future a more powerful rival would be forthcoming. Some of the speakers seemed to be doubtful as to the name of this more perfect illuminant. But electricians have no doubt on the point.

Another Submarine Boat.—A submarine boat, called the *Peacemaker*, has been designed in America for placing torpedoes under the bottoms of war vessels. The boat is 30 feet long, 7 feet 6 inches wide and 6 feet deep. Her deck is to be provided with torpedo gear for discharging floating torpedoes. The proposal is to release a pair of these engines attached to each other by a cord, and provided with cork floats, and electro-magnets, and electric detonators. When released, these will rise, one on each side of the keel of the vessel to be destroyed. A current of electricity is kept passing through the magnets. The instant they come in contact with the iron bottom of a war vessel, they will adhere with great tenacity. The *Peacemaker*, after placing the torpedoes, will steam away, and when at a safe distance explode them by electricity. It is said that electricity has been tried as the motive power for the boat, but has proved unsatisfactory.

The Brighton Electric Railway.—At a special sitting of the Brighton County Court last week, Judge Martineau resumed the hearing of an action against Mr. Volk, of the Brighton Electric Railway, to recover £50 damages in respect of injuries received by a lad named Simmonds owing to the alleged negligent driving of an electric car. The case for the plaintiff was that a horse attached to a cart being startled by the whistle of Mr. Volk's driver, and by the general appearance of the car took fright and came into collision with a bicycle which he was riding, precipitating him from his seat and occasioning him some personal injuries. Further evidence was adduced in support of the claim, Dr. Stephen stating that several horses driven by himself at various times had "shied" on seeing the car approach. A fly proprietor, Maynard by name, alleged that he had seen quite fifty horses take fright at the car, in fact, one out of every hundred did so. Other witnesses having spoken in a similar strain, Mr. Lamb contended for the defence that the whistle used was quite an ordinary instrument, and a horse which would "shy" on hearing it was not fit to be brought out at all. Such an animal must be extremely sensitive, and not under proper control. He called Edward Rigglesworth, an engineer, who said that the horse was quiet and did not appear to be frightened. Defendant also gave evidence, and eventually His Honour decided to reserve judgment.

NEW COMPANIES REGISTERED.

Equitable Telephone Association, Limited.—Capital, £6,000, in £5 shares. Object: To acquire inventions relating to telephonic communication, or for machinery and apparatus for use therewith; and in particular to purchase certain inventions referred to in an agreement made with Allan Archibald Campbell Swinton. Signatories (with 1 share each) A. A. C. Swinton, 43, Grove-street, Newcastle-on-Tyne; J. M. Faulkner, 16, Jesmond Road, Newcastle-on-Tyne; O. Bruce Cavilje, 7, Leadenhall Street; W. Stamm, 14, Queen Street, E.C.; R. C. Godfrey, Wiveliscombe, Somerset; W. H. Warden, 14, Queen Street, E.C.; H. J. Peachey, Friern House, East Dulwich. Registered on the 15th inst. by Messrs. Davidson and Morris, 40 and 42, Queen Victoria Street.

Taunton Electric Lighting Company, Limited.—Capital, £10,000, in £5 shares. Objects: To carry on in Taunton, and elsewhere in the counties of Somerset and Devon, the business of an electric lighting company in all branches, and for such purpose to take over the business carried on by Hy. George Massingham, under style of "The Taunton Electric Lighting Depôt." Signatories (all of Taunton) W. Herbert Fowler, 40 shares; J. Withcombe, 10 shares; A. Lewis, 10 shares; Wm. Potter, 10 shares; C. H. Samson, 10 shares; H. B. Allen, 12 shares. Registered 16th inst. by H. F. Kite, 11, Queen Victoria Street, without special articles of association, under table A, of the Companies Act, 1862. Registered office, 22 and 23, Fore Street, Taunton.

United River Plate Telephone Company, Limited.—Capital, £500,000, in £5 shares. Object: To effect an amalgamation of the River Plate Telephone and Electric Light Company, Limited, and the United Telephone Company of the River Plate, and to carry on the Argentine Republic, the Republics of Uruguay and Paraguay and elsewhere, the business of a telephone and telegraph Company. Signatories (with 1 share each) F. W. Jones, 19, George Street, Hanover Square; F. Lloyd, 40, Hogarth Road, S. W.; H. Fitzgerald, Hardwick House, Richmond; R. E. Bateman, North View, Reigate; J. E. Kingsbury, 31, Croxted Road, Dulwich; J. W. Rhodes, Friern Park, North Finchley, merchant; T. H. Ryall, 131, Wool Exchange, merchant. The first directors are Lord Thurlow (chairman), F. W. Jones, T. Lloyd, J. Irving Courtenay, R. E. Bates, F. Green, and Major Hy. T. G. Fitzgerald. Qualification: 100 shares. Remuneration: £1,700 per annum; and in addition thereto, a sum equal to 20 per cent. of the net profits remaining over after payment of 10 per cent. per annum. Registered 17th inst. by Messrs. Renshaw, 2, Suffolk Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Harrison's Synchronous Clocks Company, Limited.—An agreement of the 11th inst. between W. S. Harrison, of 23, Falkland Road, Kentish Town, and C. C. Carfield, of 42, Islip Street, Kentish Town, provides for the purchase by the company of the letters patent No. 3,578 dated July 20th, 1883, relating to improved synchronising and time signalling mechanism. The purchase consideration is £1,000 in fully paid shares.

Blackpool Electric Tramway Company, Limited.—The annual return of this company made up to the 11th inst., was filed on the 18th inst. The nominal capital is £30,000 in £10 shares. The whole of the shares are taken up, and upon 2,850 shares the sum of £6 10s. per share has been called up. The calls paid amount to £18,497 10s. 0d., and the sum of £1,500 is considered as paid upon 150 shares. The unpaid calls amount to £27 10s. 0d. As compared with last year's return the paid up capital shows an increase of £5,755 10s. 0d.

Pilsen-Joel and General Electric Light Company, Limited.—Upon the petition of the above-named, the Chancery Division of High Court of Justice has ordered that the special resolution passed and confirmed at extraordinary general meetings of the company on the 2nd and 17th ult., be confirmed. The resolution relates to the reduction of the capital to £56,225 divided into 100 shares of £2 5s. each and 28,000 shares of £2 each. The resolution and order of the court were duly filed on the 16th inst.

United Telephone Company of the River Plate, Limited.—At an extraordinary general meeting of the shareholders in this company, held on the 1st inst. at 131, Wool Exchange, Coleman Street, it was resolved to wind up voluntarily, and Messrs. Frank William Jones and John Edward Kingsbury were appointed

liquidators, and in addition to receiving their ordinary remuneration as officers of the company, will be entitled to £500 to be equally divided between them. The liquidators were also authorised to consent to the registration of a new company under the title of the United River Plate Telephone Company, Limited. The special resolutions were confirmed and duly registered on the 16th inst.

River Plate Telephone and Electric Light Company, Limited.—At extraordinary meetings of the shareholders in this company, held on the 1st and 16th inst., resolutions were passed authorising the winding up of the company in view of an amalgamation with the United Telephone Company of the River Plate, and Messrs. Thomas Lloyd, of 34, Walbrook, and C. L. Wingfield FitzGerald, of 4, Hercules Passage, were appointed liquidators at a renumeration of £250 each. The resolutions were duly filed on the 17th inst.

CITY NOTES, REPORTS, MEETINGS, &c.

The Gülcher Electric Light and Power Company, Limited.

THE fifth ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel on Monday, Mr. Daniel de Castro presiding.

Mr. W. G. Byrne, the secretary, having read the notice convening the meeting,

The Chairman said many of the shareholders had probably not received the report and accounts until that morning instead of a week previously. This was owing to the audit having been interrupted a week in consequence of the books having been required in court on the hearing of Mr. Gilman's appeal against Mr. Justice Grantham's decision in favour of the company The accounts for the past year were presented in a somewhat unusual form. Those for the nine months ending June 30th, 1886, were believed to be absolutely correct—in fact, they were absolutely correct; but those for the twelve months ending September 30th, 1886, could only be approximately correct. The reason for this was that the directors resolved to alter the period for holding the annual general meeting, and to make the company's financial year end in future on June 30th. The advantage to be gained by this change was that the annual stocktaking would in future take place in July instead of in October, as hitherto. An electric lighting company began to get busy in the autumn, and October was absolutely the busiest month in the year, and to take stock then was a great hindrance to business. Those shareholders who had preserved the balance sheets and accounts rendered to them yearly, during the last three years, would be able to satisfy themselves as to the progress of the company. On June 30th, 1883, the share capital of the company consisted of 47,747 shares, of which no less than 19,660 had been issued to vendors as fully paid up. On June 30th, 1886, the total share capital of the company consisted of 20,097 shares (since reduced to 19,633), of which only 5,964 were vendors' paid up shares. Of these 5,964 Messrs. Fox, Johnson and Garrett were under covenant to surrender 1,374, and if the company were successful in an action pending against these gentlemen, they would shortly be burdened with only 4,590 fully paid up shares. On June 30th, 1883, the other liabilities of the company were admitted by the directors to be £19,313; on June 30th, 1886, they were only £7,265. It would thus be seen that the liabilities of the company had been enormously reduced in both directions. On the other side of the balance sheet the plant and stock in 1883 was alleged to be of the value of £20,130. The shareholders would remember very well the discussion which took place at the first general meeting, when it was admitted that this was only the roughest estimate. Afterwards, £20,000 was found to be so far in excess of the real value of the stock that in one of the subsequent years it was reduced by a very large amount, and as a matter of fact the value was really scarcely more than £12,000. The trade accounts then due to the company only stood at £1,100. On June 30th, 1886, the plant and stock stood at £31,251, and this was after a most careful valuation for which their manager vouched. The trade accounts due to the company stood at £1,917. These figures, he thought, spoke for themselves. With reference to the manufacturing and trading accounts for the 14 months ending June 30th, 1883, the total works expenditure was over £24,000, of which £2,876 was charged for superintendence. The result of the expenditure of this £24,000, or in other words the sales, amounted to £5,600, the admitted manufacturing loss being £6,874. For the nine months ending June 30th, 1886, the corresponding items were:—Works expenditure, £13,500, barely half what it was in the previous period of 1883, while in the nine months the sales realised £11,575, more than twice what was realised in the 14 months ending June, 1883, leaving a net manufacturing profit of £828. In this department, also, in which the sales, &c., had been raised from an average of £400 per month to an average of nearly £1,300 per month, the improvements had been most steady and continuous. Coming to the profit and loss account for the 14 months ending June, 1883, the head office expenditure was £4,724, and the deficit for the year was £18,590; but for the nine months ending June, 1886, the head office expenditure was £2,130, the deficit being reduced to £1,268. With regard to the deficit of £1,268, which appeared in the first nine months' account, more than half that was due to the heavy item of law charges. This sum, heavy as it was, was less than half the amount of the law charges for the year 1885, and the directors believed that with this item, there was a practical end to the protracted litigation in which the company had for the last three years been involved with its promoters and original directors. In their action with the old directors the present board ventured to think they had done very well. As to the action with Mr. Blundell, who insisted on his strict legal rights, it was not for him (the chairman) to criticise the conduct of the case, but he could not refrain from saying that the company's case was not heard. If it had been, the result, he was sure, would have been different. Following the precedent that was set three years ago the auditors had placed below the line in their profit and loss account losses connected with matters not strictly within the business of the last nine months. That account dealt with the Gülcher patent, with some of Mr. Crookes's lamps, and with Mr. Blundell's claim, all of which were liabilities incurred previous to the last nine months. To continue the criticism of the accounts, they stated that from the 1883 manufacturing account it would be seen that the sale and hire of dynamos during the 14 months amounted to £5,646; for the nine months ending June, 1886, they amouted to £11,450. That increase was not a sudden one. In 1884 the amount was £9,000, and in 1885, £10,800. The gradual progress was the same in the profit and loss account. In 1883 the admitted loss was £6,874; in 1884 it was £6,290, but the larger proportion of that loss was incurred in the previous year's trading. In 1885, instead of there being a loss, there was a profit of £120, and this year the profit was £1,053. There were a few other items which it would be useful to notice. The superintendence of works in 1883 stood at £4,650; in 1884 it was reduced to £1,882; in 1885 it came down to £433, or less than one-third of the amount for the previous year; and for the nine months of 1886 it was £375. These figures showed what economy had been effected. Taking the profit and loss account for 1883, it would be seen that the salaries, city office expenses, and directors' fees amounted to £2,933, while the total balance written off as lost was £18,678. In 1884 the directors' fees, salaries, and city office expenses were just £1,600, and the deficit about £20,000: but there again the deficit was largely due to what was done in the preceding year. In 1885 the same items amounted to £1,040, while the balance carried down was £6,800, or less than one-third of that of the previous year; while in 1886 the same head office expenses and fees were less than £1,000, and the balance carried down £1,557 only. In all this would be seen the gradual steady decrease of expenses year by year, and the gradual steady increase of items which indicated profit. Since their last meeting they had issued £5,000 of debentures. The shareholders who had subscribed were by no means the wealthy ones, but had been that body of shareholders who had supported the present board from the beginning. He had no doubt, however, that the wealthy ones would soon come forward now that they saw the concern was likely to be a flourishing one. £3,000 had been obtained from the shareholders he had mentioned. The other £2,000 had been subscribed by the directors, and he himself was the largest debenture holder in the company. The company, he hoped, was now going to do a real business; it was no longer going to drag along as it had been doing. It had done with deficits. But to do business, the directors must have money at command. They did not want very much at present, but they had taken power as a board to issue £20,000 of 7 per cent. debentures, and they had explained in the report how they proposed to deal with it. £15,000 they proposed to keep for the purpose of issuing as they required it. If they got a very heavy order—and they had two or three in view—and their working capital should be inadequate to carry it out, they would then invite the shareholders to subscribe such an amount as they deemed necessary. These debentures would, of course, only be a second mortgage at present, because the £5,000 first mortgage debentures must remain so unless the debenture-holders chose to waive their rights. £5,000 second mortgage debentures, however, would be kept in reserve for the purpose of redeeming the £5,000 first mortgage debentures, when it became due, so that in two years' time these second mortgage debentures would spring into existence as a first charge. He hoped that this scheme would meet with the approval of the shareholders. Having stated that the company had great reason to regret the retirement of their late secretary, Mr. Russell Day, who had gone through the heat and burden of the day with them, and had worked in a way that no one could appreciate properly except the chairman, Mr. De Castro referred in complimentary terms to other employés, particularly to Mr. Mountain, the manager, and to Mr. Fricker, the electrician. He continued to state that the board had elected two new directors who were likely to assist them very materially—Mr. Henry Grëwing, of the firm of Messrs. Oppenheim and Sons, and Mr. Thomas Lloyd, both of whom had considerable interest in the electrical world. Each of these gentlemen had started by taking debentures as an earnest that they meant business.

Mr. Murray asked how the directors proposed to deal with the loss of £71,000.

The Chairman said the board had discussed this question more

than once. When they had got a surrender of the shares which Messrs. Fox, Johnson, and Garrett were under covenant to surrender, they proposed to bring before the shareholders a scheme for reducing the capital down to the intrinsic value of the shares —namely, to about £25,000 or £30,000. Then they would be able to declare a dividend out of any profit they might earn. At present, if they earned a profit next September—and they meant to do so—it would have to be carried to credit in reduction of the losses, and in that way there would be no possibility of a dividend for many years. If they adopted some such scheme as he had suggested, he saw no reason why the company should not be a dividend-paying concern in the course of the next two years. The Chairman then moved the adoption of the report and the accounts, which was seconded by Mr. Lloyd, and unanimously carried.

On the motion of the Chairman, seconded by Mr. Cunningham, a vote of thanks was awarded to Mr. Day, the late secretary; and an honorarium of 50 guineas was awarded to Mr. Mountain, the manager, in consideration of his great exertions in the interests of the company.

The retiring directors and Messrs. Edwards, Jackson, Browning, and Husey, the auditors, were unanimously re-elected, and a vote of thanks to the chairman and directors concluded the proceedings.

The New Telephone Company, Limited.

THE annual general meeting of this company was held on Saturday last at the offices of the company, 4, Great Winchester Street, E.C., Lord Thurlow, the chairman of the company, presiding.

The Chairman stated that the progress made during the year in sales was satisfactory and encouraging. The instrument they dealt in, the Silvanus Thompson telephone, had been greatly improved. It had been found too delicate for exchange work at the commencement, but it had been strengthened, and the company now possessed a telephone second to none as a commercial instrument for loud speaking and for long distances. The finances of the company were in a sound and satisfactory state, and the directors intended early in the year to proceed to the formation of a large and powerful company to establish telephone exchanges at Birmingham, Manchester, Liverpool, and all the large towns in the Midlands and in the North of England.

A vote of thanks to the directors terminated the proceedings.

The River Plate Telephone and Electric Light Company, Limited.

AN extraordinary general meeting of this company was held on Monday at the offices, Walbrook, Mr. Thomas Lloyd in the chair, when the resolutions passed at the meeting on the 1st inst. were submitted for confirmation. They were for effecting an amalgamation of the company (except as regards its Uruguay business) with the United Telephone Company of the River Plate, Limited, and winding up the company; appointing Mr. T. Lloyd and Mr. C. L. W. Fitzgerald liquidators; and approving an agreement between the company, of the first part, the United Telephone Company of the River Plate, of the second part, Richard Rogers on behalf of the United River Plate Telephone Company, Limited, about to be incorporated, of the third part, the Consolidated Telephone Construction and Maintenance Company, Limited, of the fourth part, and Frank Williams Jones, of the fifth part.

On the motion of the chairman, the resolutions were unanimously confirmed.

The Eastern Extension, Australasia and China Telegraph Company, Limited.—This company notifies that the coupon on the 5 per cent. Australian Government subsidy debentures, due on January 1st next, will be paid on and after that date at Messrs. Barclay, Bevan & Co.'s, 54, Lombard Street, E.C. Coupons must be left three clear days for examination.

The Eastern and South African Telegraph Company, Limited.—This company notifies that the coupon and interest warrants, due on January 1st next, on its 5 per cent. mortgage debentures, will be paid on and after that date at the banking house of Messrs. Barclay, Bevan & Co., 54, Lombard Street. Coupons should be left three clear days for examination.

The Electro-Amalgamator Company, Limited.—The members of this company have passed a resolution to wind up the concern, and Mr. Arthur George Snelgrove has been appointed liquidator. The same course has been adopted by the New Electro-Amalgamator Company, Limited.

Great Northern Telegraph Company, Limited.—An interim dividend at the rate of 5 per cent. per annum will be paid on January 1st next, by Messrs. C. I. Hambro and Son, 70, Old Broad Street, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 17th were £3,856 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th December are £2,278, as compared with £2,504 in the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending December 17th were £4,665.

NEW PATENTS—1886.

16510. "Controlling electric currents at varying speeds of a generating dynamo." M. IMMISCH. Dated December 16.

16578. "Switches for making and breaking circuits." C. M. DORMAN, R. A. SMITH. Dated December 17. (*Complete.*)

16608. "Producing coherent masses of peroxide of lead for use as voltaic battery elements, &c." D. G. FITZGERALD. Dated December 17.

16616. "Employing vibrating electricity in telegraphy." C. LANGDON-DAVIES. Dated December 17.

16633. "Instrument for use in testing dynamo-electric machines, &c." J. RYAN. Dated December 18.

16650. "Electric apparatus for the control of watchmen." O. SKRIVAN, F. DVORAK. Dated December 18. (*Complete.*)

16660. "Making or treating materials for the filaments of or the incandescing media of electric lamps, &c." T. MACE, H. EDMUNDS. Dated December 18.

16661. "Self-regulating electric generators." R. P. SELLON, W. M. MORDEY, C. E. WEBBER. Dated December 18.

16662. "Automatically regulating electric generators." R. P. SELLON, W. M. MORDEY, C. E. WEBBER. Dated December 18.

16675. "Primary battery. N. G. THOMPSON. Dated December 20.

16678. "Dynamo-electric machines with slotted armatures." G. HOOKHAM. Dated December 20.

16739. "Dynamo-electric machines." C. G. CURTIS, F. B. CROCKER, S. S. WHEELER. Dated December 21. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

13422. "A new or improved galvanic battery with apparatus for automatically supplying liquids thereto." W. A. BARLOW. (Communicated from abroad by Marcel Sappey, of Paris.) Dated November 5. 1s. 1d. Has for object a new electric generator with automatic feed, and is composed of a certain number of batteries, which are themselves composed of several elements. The generator forming the subject of the invention is composed of carbons and zincs as well as a porous cell, and two liquids are employed, but it differs from all other batteries as made by reason of its special arrangement and particular construction. The claims are 7 in number.

14695. "Improvements in electrical apparatus for releasing door and similar fastenings." C. L. CARSON. Dated November 30. 8d. Has for its object an improved means of releasing the bolts or fastenings of doors, more particularly those of theatres and other public buildings, by a weak current of electricity, thereby rendering exit possible by merely pushing open the doors. The claims are 2 in number.

13694. "Improvements in voltaic batteries." J. P. REES and T. D. C. PARKER. Dated November 10. 8d. Claims:—1. The improved arrangement and construction of voltaic batteries in such manner that the porous pots, carbon and zinc plates can be so supported that they can be raised or lifted out of the cells containing the exciting fluid, and thus arrest the action of the battery, substantially as described and represented in the drawings. 2. The forming of the porous cells with overflow lips or channels to conduct the spent liquor into a receptacle, forming part of or combined with the battery, substantially as shown and described. 3. The application of an envelope or cover to the battery box, arranged with a water or other air-tight joint to prevent the escape of fumes from the battery, substantially as shown and described in the drawings.

14156. "Improved means of generating or inducing electric currents for actuating relays, block signalling, and interlocking apparatus on railways and tramways." J. RADCLIFFE. Dated November 19. 6d. The inventor uses one or more permanent or electro-magnets, the pole pieces of which he surrounds with coils of insulated wire, fixed underneath or in close proximity to the rails of the permanent way, so that the deflection or vibration of the said rails by passing engines or vehicles may directly, or by means of armatures attached to levers connected to the rails, generate or induce currents of electricity in the said coils of insulated wire, which may be used for actuating relays, block signalling instruments or interlocking apparatus, and for placing semaphore or other signals at danger or otherwise. Claims:—1. Generating or inducing currents of electricity by means of the vibration or deflection of the running rails of railways or tramways. 2. In attaining the above result, the employment of a permanent or electro-magnet, the coils surrounding the pole pieces or armatures of which are connected in close circuit with the relay or other receiving apparatus, in such a manner that the currents induced in the said coils may actuate the said relay or other apparatus. 3. Actuating relays, block signalling, interlocking and other electrical apparatus by means of induced currents produced by the deflection or vibration of the rails of railways or tramways.

14917. "Improvements in telephony and telegraphy." S. Z. DE FERRANTI and G. L. ADDENBROOKE. Dated December 4. 8d. Claims:—1. Improvements in telephony, consisting in the use therein of an induction apparatus, of which the primary forms part of a local circuit, including a battery and a telephone transmitter; and the secondary forms part of a line circuit, such primary and secondary coils being wound upon an iron core, which is either formed into a complete ring or rings, or which has its ends approximated so that the magnetic circuit in the core is completed through metal, or more nearly so than when a straight core is employed. 2. Improvements in telephony, consisting in the use therein of an induction apparatus, of which the primary forms part of a subscribers' line or local circuit, and the secondary forms part of a main circuit; such primary and secondary coils being wound upon an iron core, which is either a complete ring or rings, or which has its ends approximated so that the magnetic circuit in the core is completed through metal, or more nearly so than when a straight core is employed. 3. The combination of a line circuit with at each end of the same, induction apparatus having as stated above a magnetic circuit closed or partially closed through metal; such induction apparatus serving to couple the line circuit inductively with two other circuits, one including an electric bell or mechanical indicator, and the other a magneto electric machine or other source of rapidly alternating or varying currents; the whole forming a mechanism by which a bell may be rung or indication given on one circuit by varying currents originated in another, and this through the intervention of a third circuit. 4. The arrangement and combination of telephonic mechanism, substantially as described.

14963. "Improved induction apparatus." S. SCHUCKERT. Dated December 5. 6d. Claims:—1. An induction apparatus wherein cylinders or end pieces, made of separate pieces of iron wire or sheet iron are applied to the prolonged or flanged ends of a core, as described. 2. The magnetic connection of the two ends of the core of an induction apparatus, constructed as described by means of a hollow cylinder or sheeting made of separate wires or sheets touching the circumference of both end pieces of the core, substantially as specified. 3. The obtaining such magnetic connection of both ends of the prolonged or flanged core of an induction apparatus by forming the end pieces, and a cylinder from a single piece (which encloses the coils cylindrically), the ends of which are bent down on to the prolonged ends of the core, or are bent over the flanged ends of the core.

14986. "A new or improved electric and storage battery." G. J. ATKINS. Dated December 7. 6d. Consists in the employment of carbon for both the positive and negative elements with any suitable electrolyte. The carbon intended to form the positive element may be separated from that intended to form the negative element by means of a porous partition or other suitable or usual means. The carbon may be used in a more or less divided form, or shaped into plates, rods, or otherwise, according to circumstances.

15285. "An improvement in manganese voltaic batteries." B. PELL. Dated December 12. 4d. Claim:—In manganese voltaic batteries, surrounding the carbon electrode with a granular mixture of manganese and carbon, enclosed within a perforated jar, substantially as and for the purpose herein set forth.

15324. "Improvements in and in connection with telegraphing and telegraphing apparatus used in connection with engines." W. CHADBURN. Dated December 14. 8d. Claims:—1. The improvements in telegraphing described, which consist essentially in effecting the indication upon the bridge, or other portion of a vessel, the position of the reversing mechanism of an engine combined with the condition of the steam controlling, or governing device. 2. The combination with means for indicating upon the bridge or other part of a navigable vessel, the position of the reversing gear of the engines, of a device for telegraphing and indicating the position of the steam controlling or governing device to said bridge or other part, substantially as set forth. 3. In combination with the reversing gear of a steam engine and the steam controlling or governing apparatus, the device for telegraphing the position of such steam controlling apparatus, substantially as set forth, with reference to the drawings, or any mere modification thereof.

15422. "Improvements in apparatus for completing and breaking electric circuits." O. E. WOODHOUSE and F. L. RAWSON. Dated December 15. 8d. Relates to apparatus for completing and breaking electric circuits in a simple and efficient manner, with which may be combined a safety fuze for automatically breaking the circuit when the current is in excess of any desired amount. The claims are 5 in number.

15601. "Improved apparatus for holding or gripping cables." W. C. JOHNSON and S. E. PHILLIPS. Dated December 18. 8d. Claim:—The construction and use of a mechanical cable copper wherein two wedge cheeks, mounted free to slide longitudinally between sloped flanges of a frame, are caused by the drag of a cable engaged between them to grip it tightly, substantially as described with reference to the drawings.

15658. "Improvements in electrical switches." B. M. DRAKE and J. M. GORHAM. Dated December 19. 8d. The inventors employ a ring, or a number of rings, arranged concentrically. The said ring or rings is or are cut or divided at one side, or portion, and into the aperture or aperture thus made the switch lever, or piece, is pressed to make the requisite contact. The claims are 4 in number.

15794. "Improvements in posts for telegraph or telephone lines." A. EADIE and J. TANNAHILL. Dated December 23. 8d. The pile or bottom part of the post, which is fixed in the ground, is made with a tapered socket and with a flange at its upper end; and the post, which consists of a tapered tube of wrought iron or steel, is made with its bottom end tapered to fit the socket in the pile. The tapered bottom end of the post is made with its widest part a little wider than the part immediately above it so as to form a shoulder, and a ring, which is passed over the upper smaller end of the post, is shaped to bear on the shoulder, and being secured by screw bolts to the flange of the pile holds the post firmly down in its socket. The claims are 3 in number.

CORRESPONDENCE.

Electric Cars.

I feel it to be indirectly a compliment to have my name associated with Mr. Reckenzaun's, even though charged with being a copyist, and I admit at once that the success he achieved by the employment of worm gear encouraged me to adopt it on a large scale; but I must take exception to the statement that he was the first to use worm gearing for the propulsion of electric vehicles; it must have been a little forgetfulness on the part of the writer of the paragraph. Mr. Reckenzaun, I know, lays no claim to novelty.

In 1883 I had a little car driven by worm gearing, and Mr. L. J. Crossley, in the same year, also ran a car at Moorside on which worm gearing was employed. The novelty of the arrangement on my French car (not Blackpool) consists in combinations and details to avoid loss by excessive friction of the worm, overheating of the thrust block, and cross-strains by the ever varying relation between the motor and axle, and in the attainment of these objects I have been most successful.

Your illustration gives a capital idea of the general disposition of parts, but does not clearly indicate how the objects sought have been attained.

M. Holroyd Smith.

December 16th, 1886.

Bourseul's Magneto-Telephone Receiver identical with Bell's.

I herewith send to the REVIEW several columns of the *New York Herald* of 2nd and 3rd instant, giving the latest sensational news touching the Bell telephone patents, and the decision of the judges, who have adjudged that Bell is the inventor of the *art* of telephony, and the deduction follows, if their decisions be sustained by the Supreme Court of the United States, that no one can make or use any instrument which practises telephony by the use of a "*closed circuit*."

The United States Courts are to hear the several appeals from those decisions on the 25th January next, as I heretofore informed you. Several facts are substantiated by the documentary evidence cited in the *Herald*. 1. One fact is, that in the several suits cited there was collusion between the parties—that is, between the Bell Company and each of the defendants. 2. Another fact is, that large interests in the Bell Company were held by immediate relatives of judges Lowell and Gray, before whom the first suits were brought, and who decided all points in favour of Bell. 3. Another fact is, that other judges before whom similar suits were brought accepted by *courtesy* the decisions of these judges, and rendered similar decisions. The publication in the *Herald* of 2nd inst. has caused great excitement in the Bell telephone coterie, and also has agitated in no small degree that of the opponents of the Bell monopoly.

In addition to the judgments referred to by the *Herald* there are two other decisions in favour of Bell, viz., that of Bell *v.* the Molecular Telephone Com-

pany, of New York, who used the Lockwood-Bartlett telephones, and of Bell against the Pan Electric Telephone Company in New Orleans.

The decision against the Molecular Company was rendered by Judge Wallace of the United States Court in New York, who cited the decisions of Gray, and of Lowell, as binding, *through courtesy*, on him; but he went farther, and decided that the small hole in the ear pieces of the Bell receiver was "*a tube*," as Bell claims "a tube" for speaking into, "and for hearing therefrom." It may be asked whether a hole in a thin material not more than $\frac{1}{16}$th of an inch thick can, by any person possessed of common sense, be called "*a tube*."

The pleadings in the molecular case presented the strongest evidence against the Bell claims, but it seems to me that the strongest point against Bell's claims was not brought before the court by the Molecular counsel, who relied principally upon the inventions of Reis.

In their pleadings the articles describing Bourseul's telephone from Baille, published in 1868 in France, and in the United States at Boston in English in 1873, and in *Didaskalia*, both of which I furnished to the REVIEW in 1883 and 1884, were set out, but it seems that the counsel for the Molecular failed to bring the Bourseul telephone before the judge. I cannot but believe that had a receiver been made strictly according to the description of it, the judge would have clearly seen that it was a perfect Bell telephone with the flexible iron plate near to but not touching an electro-magnet, and his decision could not fail to have decided that the instrument described by Bell as his receiver, was described by Bourseul in a printed publication in 1854, a translation of which I sent you some time ago.

I now inform you that the original from which I made that translation was published in a Paris paper entitled *Journal Universel*, August 26th, 1854.

It will be recollected that Bourseul described his receiver to be "an electro-magnet, though the wire surrounding it passes a current of electricity coming from the transmitting end of the wire in combination with a movable plate so flexible that it will not miss any of the vibrations produced by the voice."

Is not this a correct description of Bell's receiver? Could a mechanic with the knowledge only of that period, 1868, having Bourseul's description before him (as published in *Wonders of Electricity*, by Baille, in the library of the British Museum at that period) fail to make a Bell receiver?

I submit that this description having been published in England prior to the date of Bell's patent, any person has an indisputable right to make a Bourseul receiver, and, further, that Bell was not the *first* inventor of that instrument in England.

I cite the opinions of the late Master of the Rolls as conclusive that any person has a right to make and use that instrument in England.

The Master of the Rolls in the case of United Telephone Company *v.* Harrison, Cox-Walker, 1882, in his "judgment," said:—"Though nobody knows how to make a receiving instrument, if we are told this is a telephone receiver that will give articulate sound, it would nevertheless be a publication, though nobody knew how to work it;" and Lord Justice Bowen on the Bench with the Master of the Rolls in the same suit, said:—"I can conceive an instrument being useless at the time when its use was not known, but which afterwards became useful."

Apply these learned judges' decisions to the Bourseul receiver, and does it not follow that Bourseul's receiver is free from any claim in Bell's patent, and that it can be used not only as a receiver, but for any purpose whatever. Its use as a transmitter, it seems, "was not known;" but, as Lord Justice Bowen said, it becomes useful now.

In view of the publication in England in 1868 of Bourseul's receiver and the above-cited decisions, I submit that the Bell patent is void in England, and I hope that some of your telephone companies, who have been crushed by the Bell patent, will proceed to make, sell, and use Bourseul's instruments, and give the United Telephone Company an opportunity to have their patent declared void by the Court.

W. C. Barney.

New York, *December 6th*, 1886.

Plums from the Law Courts.

In accordance with precedents I send you a few plums—mostly from the bar—dropped during the late tempest of litigation. I may add, that these plums were evolved from silk of the very richest and highest quality.

A long water pipe offers no more resistance to the flow of water than a short length of the same pipe. This "fact" proves that after all there is a difference between the electric "fluid" and "other fluids."

A low resistance lamp may have a filament of high resistance in it. (How many ohms is the lamp less than its filament, pray?)

A straight filament gives out less heat than the same filament coiled up.

Incandescent lamp makers always join the raw filaments to the platinum wires *before* carbonisation.

If you lower the resistance of a filament, and also lower the E.M.F. correspondingly, it will require less current to make it incandesce in the same proportion.

You cannot make a carbon filament in any other way than by carbonising something which is a filament to begin with.

If an incandescent lamp, while burning, has its globe broken open, not a trace of filament is left. It is all burned up to nothing in an instant.

Carbon is a substance which has a low specific resistance, much lower even than platinum or any of the metals. So much so, that it is impossible to scrape down a pencil of carbon so that it will have a high resistance. Therefore, the carbon wire of Swan's Newcastle lamp, exhibited before the date of Edison's patent, was not a carbon filament.

It is impossible to make a carbon filament out of plumbago (although Edison describes a special way of doing this by stamping it out with a die).

You cannot possibly uncoil a carbon filament without breaking it.

l'Homme Qui Rit.

Why Burn Oil?

Can any of your readers kindly help me? By adv. in your paper I see that chromic acid is 20 times as strong a depolariser as bichromate of potash. Is this anything near the mark? I have eight cells (with porous jars), for which I use the following quantity and proportions:—

		s.	d.
Sulphuric acid	8 lbs. costs	1	0
Bichromate Potash ...	2¼ lbs. „	1	1½
Water	18 lbs. „		
Porous cell acid 1 to 25 water... ...		2	1½

This lights 10 C.P. lamps* of 10 volts 15 minutes a day for about 90 days, or roughly speaking, is capable of 30 hours' work if used right off. Now, the chromic acid solution is:

?	Chromic acid	1 lb. at 8d. =	8d.
	Water	2 lb. =	
	Sulphuric acid ...	½ lb. =	¾d.
			8¾

The bichromate solution makes 14 pts. = 2s. 1½d.
The chromic acid solution „ 14 pts. = 5s. 1¾d.

therefore, to make it equal in cost in consumption to the bichromate it should do 2½ times the work, and so far no gain. By adv. it should be 20 × 30 hrs. = 600 hrs., or about 10 hours for 1d. Then, why burn oil?

Atom.

* Our correspondent does not state how many lamps.—EDS. ELEC. REV.